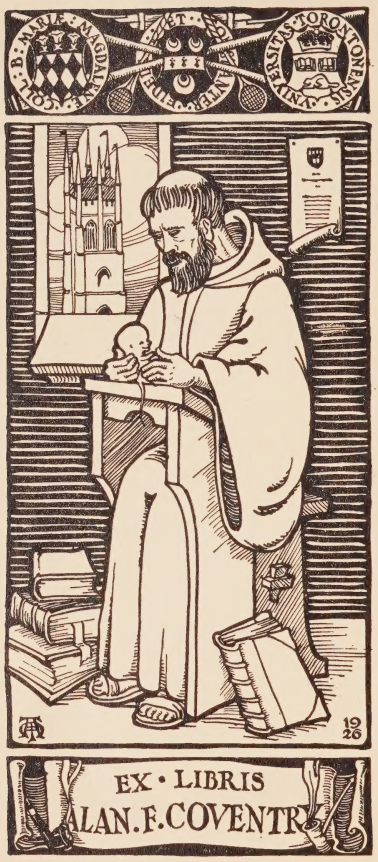
RIVER VALLEY DEVELOPMENT IN SOUTHERN ONTARIO

DEPARTMENT OF PLANNING AND DEVELOPMENT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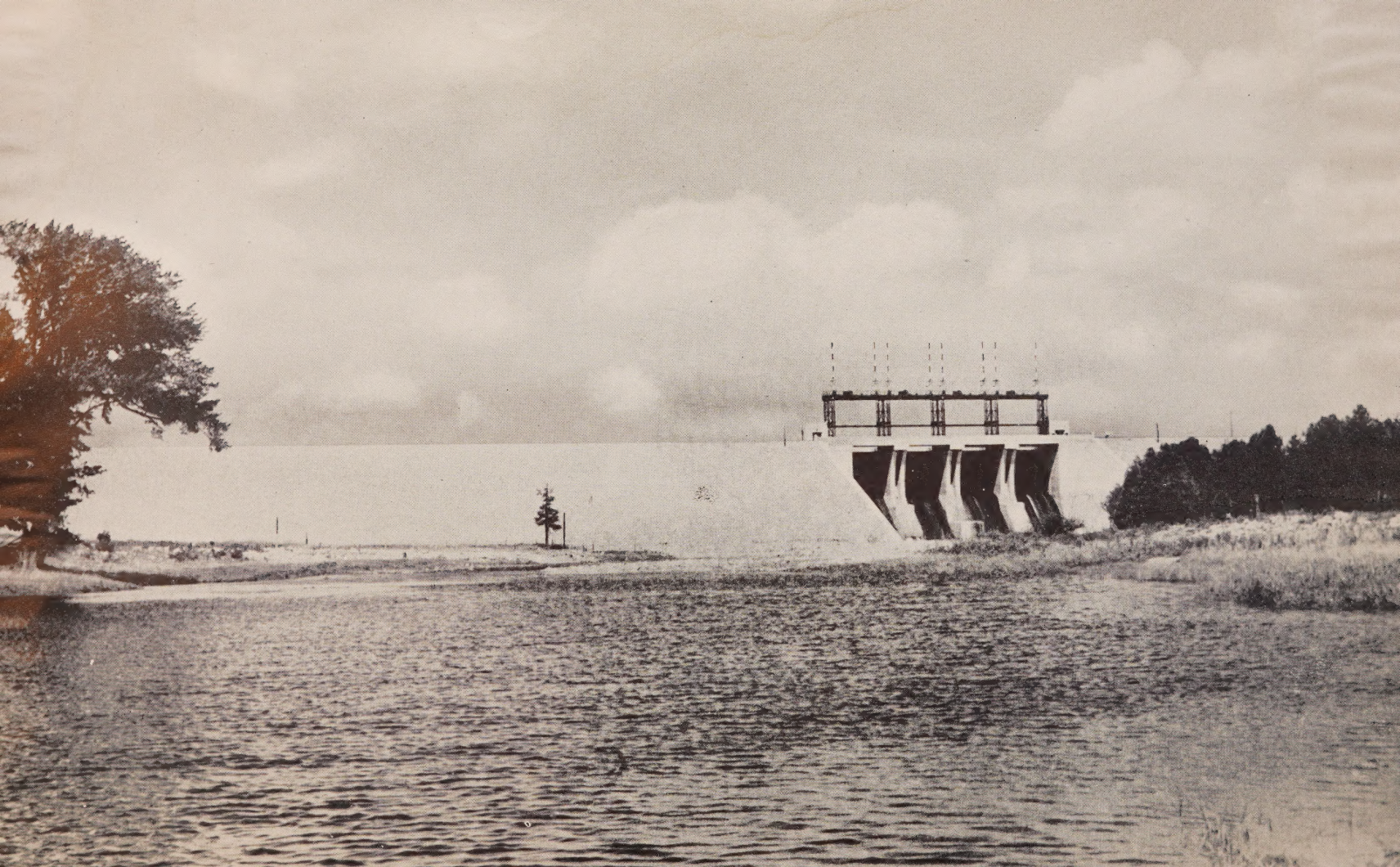
ALAN. F. COVENTRY

"I write of the Tennessee Valley, but all this could have happened in almost any of a thousand other valleys where rivers run from the hills to the sea. For the valleys of the earth have these things in common: the waters, the air, the land, the minerals, the forests. In Brazil and in the Argentine, in China and in India, in Canada and the United States, there are just such rivers, rivers flowing through mountain canyons, through agricultural land, through barren wastes—rivers that in the violence of flood menace the land and the people, then sulk in idleness and drought—rivers all over the world waiting to be controlled by men."

—DAVID E. LILIENTHAL.

(Over the page)—*The Grand River Dam (Shand Dam) near Fergus, Ontario.*
Photograph by R. F. Legget.



DEPARTMENT OF PLANNING AND DEVELOPMENT

Hon. Dana Porter, Minister Dr. G. B. Langford, Director

A. H. Richardson, Chief Conservation Engineer

RIVER VALLEY DEVELOPMENT

IN

SOUTHERN ONTARIO

Papers and proceedings of the Conference on River Valley Development in Southern Ontario held at London, Ontario, October 13th and 14th, 1944.

ONTARIO

Printed by
T. E. BOWMAN
Printer to the King's Most Excellent Majesty
Toronto
1945

INTRODUCTION

A Conference on River Valley Development was held at London, Ontario, October 13th and 14th, 1944, by the Department of Planning and Development in order to discuss the complex problems involved in such a programme. Its purpose was to provide an opportunity for groups and individuals in Southern Ontario who had been working on this problem to come together and discuss the various types of work which should be done. Invitations to attend the Conference were sent to all municipalities in the river valleys of Southern Ontario, educationalists, government officials, engineers, etc., as well as to executives of all organizations of the Province who are interested in the general field of conservation. The registered attendance at the Conference, numbering 250 may, therefore, be considered a representative cross section of the citizens of Southern Ontario.

The Conference commenced on Friday, October 13th, at 2:30 p.m., the delegates being welcomed by the Honourable Dana Porter, Minister of the Department of Planning and Development, and His Worship, Colonel W. G. Heaman, Mayor of the City of London. Dr. G. B. Langford, Director of the Department of Planning and Development acted as Chairman for the first session at which the following papers were presented: "The Need of River Valley Development in Ontario" by Professor A. F. Coventry, "The Story of the Muskingum Project" by Bryce C. Browning, and "The Need for Urban and Rural Co-operation in River Valley Development" by W. H. Porter.

At 6:30 p.m., the delegates assembled for dinner at which Dr. W. A. Albrecht, Soils Department, College of Agriculture, University of Missouri, Columbia, Missouri, was the guest speaker. The first part of Dr. Albrecht's address was broadcast over Station CFPL, London, the major part was then given with the use of slides and diagrams. Following the address of Dr. Albrecht, a number of motion picture films were shown, describing water power, wildlife, modern methods of farm tillage, and other subjects describing the general field of conservation.

W. Philip, Chairman of the Grand River Conservation Commission, Galt, acted as Chairman for the Saturday morning meeting at which the following papers were presented: "Reforestation as a Means of Controlling Run-off" by E. J. Zavitz, "Erosion Control and Soil Conservation" by Professor G. N. Ruhnke, "Underground Water Supplies" by Dr. J. F. Caley, and "Stream Sanitation" by Dr. A. E. Berry.

The Saturday noon luncheon was in charge of the Ontario Conservation and Reforestation Association with the President, Dr. J. H. Munro, of Maxville, presiding. At this meeting, the Honourable W. G. Thompson, Minister of Lands and Forests, officially released the Ganaraska Report, after which Mr. J. D. Thomas, of London, presented the Minister with a copy of the Report, bound in leather. Mr. E. K. Hampson, Chairman of the Guelph Conference, Hamilton, then gave a brief talk on the origin and significance of the Ganaraska Report.

Professor J. D. Detwiler, President of the Canadian Conservation Association, London, was Chairman for the Saturday afternoon session. Two papers were presented at this meeting, "Grand River Conservation" by E. F. Roberts, and "A Reconnaissance Survey of the Upper Thames Watershed" by W. R. Smith. This was followed by a report and presentation of resolutions by Professor R. F. Legget, Chairman of the Resolutions Committee.

All the above papers will be found in the body of this publication in the order in which they were given.

An interesting feature of the Conference was an exhibition of approximately 100 photographic enlargements, maps, bulletins, books, and trees, kindly loaned by Government Departments, Universities and delegates. These were studied carefully by the delegates, and helped to supplement the information which was presented by the various speakers.

—A.H.R.

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NATURAL RESOURCES RESEARCH COMMITTEE

Mr. A. H. Richardson, Chief Conservation Engineer, Department of Planning and Development (Chairman).

Dr. Harvey Agnew, Associate Secretary, Canadian Medical Association, Toronto.

Professor A. F. Coventry, Department of Zoology, University of Toronto, Toronto.

Mr. G. M. Dallyn, Executive Secretary, Canadian Geographical Society, Ottawa.

Professor R. O. Earl, Dean of Arts, Queen's University, Kingston.

Mr. James Farrington, Assistant Deputy Minister, Department of Game and Fisheries, Toronto.

Professor W. J. K. Harkness, Director of the Ontario Fisheries Research Laboratories, University of Toronto.

Dr. Otto Holden, Chief Hydraulic Engineer, Hydro-Electric Power Commission of Ontario, Toronto.

Dr. M. E. Hurst, Provincial Geologist, Department of Mines, Toronto.

Mr. R. N. Johnston, Chief of the Division of Research, Department of Lands and Forests, Toronto.

Professor R. F. Legget, Department of Civil Engineering, University of Toronto, Toronto.

Mr. J. E. McCague, President Holstein-Friesian Association, Alliston.

Professor E. G. Pleva, Department of Geography and Geology, University of Western Ontario, London.

Professor G. N. Ruhnke, Director of Soil Surveys, Ontario Agricultural College, Guelph.

LONDON CONFERENCE REGIONAL COMMITTEE

Dr. J. D. Detwiler, Professor of Applied Biology, University of Western Ontario, Chairman.

Mr. James A. Vance, County Engineer's Office, Woodstock.

Dr. John A. Gunton, Department of Chemistry, University of Western Ontario.

Professor M. A. Garland, Organizer of Rural Institutes, University of Western Ontario.

Mr. Watson H. Porter, Editor of the Farmer's Advocate, London.

Mr. W. H. Riehl, City Engineer, Stratford.

Mr. C. A. Park, Farmer, 19 Dufferin Avenue, Chatham.

Lieut.-Colonel William Veitch, City Engineer, London.

Mr. W. Raywood Smith, Middlesex County Engineer, London.

Mr. W. K. Riddell, Representative, Middlesex County, Department of Agriculture.

Colonel Walter James Brown, Executive Secretary, University of Western Ontario.

1

ADDRESS OF WELCOME

The Honourable Dana Porter
Minister, Ontario Department of Planning and Development

IT IS a very great pleasure indeed, as the head of this new Department of Planning and Development, to extend a welcome to you here today.

Ever since this Department of the Government was established last May, Dr. Langford has been devoting a great deal of his time to the consideration of the sort of problems that we have come here to discuss.

If the problem of flood control, which exists not only in the Thames Valley but in other river valleys of the Province, is to be tackled in an effective way, it seems to us that a great many complicated factors will have to be taken into consideration.

We have come to the conclusion that there is no one simple solution of the problems that are before us. For that reason we thought it would serve a purpose to hold a meeting of this kind, consisting of the representatives of the municipalities in this River Valley and the Grand River Valley and in certain other places—we have here representatives from the Ganaraska Valley, where the town of Port Hope is situated—for the purpose not only of hearing from men of experience in various lines of conservation ,and in matters relating to flood control, but also that we may have a discussion from the delegates here as to their views on how this situation might be handled in a practical way.

Now, it seems to me that in view of the rather complicated nature of various problems that will be before us that we must not look for any quick and ready and simple solution of the problem, but we must try to regard it rather as one that will need a programme which may extend over the next ten years for its final completion. It will involve in some places a reforestation programme. In others it may have to do with the present system of drainage that exists in some parts of this country. It may have to do in some parts of the country with agricultural methods that are being followed. It may also result in certain public works being required. In no one of these various fields of enquiry can we find the whole solution.

We will hear later during this conference about the work that has already been done by way of a survey on the Ganaraska Valley. We have decided that work should commence as soon as possible to carry out the recommendations of that survey and to formulate a policy which will be carried out in that much smaller valley than the Thames. There to some extent we may be able to experiment and demonstrate what policies will be successful and what might turn out not to be so successful.

The main necessity in a programme of this kind is that it must have, to be really effective, the fullest possible co-operation and the fullest understanding, not only of the technical men who may be engaged in working it out, but on the part of the people who are living in the region. They will be most closely affected by the policies that are adopted, and that is one reason why a conference of this kind can be of great value. Unless we can, in the course of working out our policy, keep the public fully advised and fully aware of the nature of the problems, and unless we can carry their continued support, any policy that may be attempted by any Government will be sure to fail.

Therefore, I think that in view of the large response that has resulted from the invitations that have been issued to this Conference, it is quite apparent that the public are fully aware that the problem exists and are determined that some solution, or a number of solutions perhaps, will be found and applied.

May I conclude by saying once again that we welcome you here on behalf of this Department of the Government, and we look forward to fruitful results from the meeting that is assembled here.

WELCOME TO THE CITY OF LONDON

His Worship, Colonel W. G. Heaman
Mayor of the City of London

IT IS a great privilege and a pleasure to welcome the delegates who are gathered here this afternoon to take part in this Conference. I am very glad at this time to extend a very cordial welcome to the Honourable Dana Porter on his first official visit to London. We are very glad to have Mr. Porter, Dr. Langford and other members of this Department with us.

We are very happy that this Conference is taking place in London. We are definitely interested in flood control and everything that goes along with it, and the City of London, Mr. Minister, is very thankful to you for having this meeting here and arranging this Conference so that the matter will be kept alive for the people, particularly in the area along the Thames Valley.

In looking over the programme, I notice that we have some American visitors. The City of London is always glad to have our friends and good neighbours from the south visit us and we are particularly pleased to have a gentleman from Missouri—who will probably show us—and also a gentleman from Ohio. We hope that they will have a pleasant time here. I know we are going to receive a lot of information from them and I know their visit will be a pleasant one. I hope when they return to their homes they will carry with them some pleasant recollections of their visit to London.

The Council and the citizens of London are delighted with the decision to hold the Conference here, and we hope that it will be conducive of much good. Again, on behalf of the citizens, I want to welcome you and Dr. Langford and the delegates who are here this afternoon.

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THE NEED OF RIVER VALLEY DEVELOPMENT IN ONTARIO

Professor A. F. Coventry
Department of Zoology, University of Toronto, Toronto

THE rivers of Ontario have played a large part in her history; they were often the main travelled ways; they are the sources of water; they have provided power; they have afforded recreation of various kinds; they have served as sewers; more recently they have often produced damaging floods, especially in spring; and many of them have in summer become reduced in flow, or fail altogether.

I have been asked to outline the present state of the rivers of the Province, especially those of its southern part, as a background to the more detailed discussions which will form the main part of this conference; and to suggest an approach to the general problem of river valley development.

By way of explanation I should perhaps say how I became interested in rivers. A large part of my professional work has been concerned with populations of animals, game and otherwise, and by an easy transition that interest became extended to their habitations—and animals are far more finicky about where they live than human beings; most of them are highly intolerant of anything like submarginal or slum conditions. In considering their habitats I was soon face to face with the question of water supply, both for fish and other water-dwelling animals, and for the land animals.

We are all well aware in a general way of the central importance of water in our lives; but it is not, I think, generally appreciated what immense amounts of water actually must be available to keep a countryside in full productivity. Some figures will suggest this. Crop plants require 300 to 500 pounds of water to produce one pound of dry crop; the production of one pound of beef is said to require some 40,000 pounds of water; and it has been estimated that to produce the flesh food taken by one adult in a year requires about 8 million pounds of water—a considerable part of the total precipitation at current figures. This does not, of course, mean that this water is removed bodily and permanently, but that it has to be available to circulate through the hugely complex chemical processes that go to make crops and stock.

To this we must add the very considerable amounts we need for domestic and industrial uses.

The fertility of our soil depends on water; any soil can become a desert if the water is removed, and there are ancient and recent examples of this very occurrence.

That we are here to discuss the care and management of river valleys suggests that we recognize the importance of the part they play—and must continue to play—in our life, and that we are not satisfied with their present condition; a conference would not be needed if everything was in good shape.

Ontario was a well-watered land when white man began to develop it; in two areas that have been recently investigated from this point of view there are about one and a third miles of watercourse to each square mile of land. In the early days many, perhaps most, of these streams contained fish; they provided swimming holes; and they gave power for mills; now after a hundred or more years of development the picture has changed in many important respects.

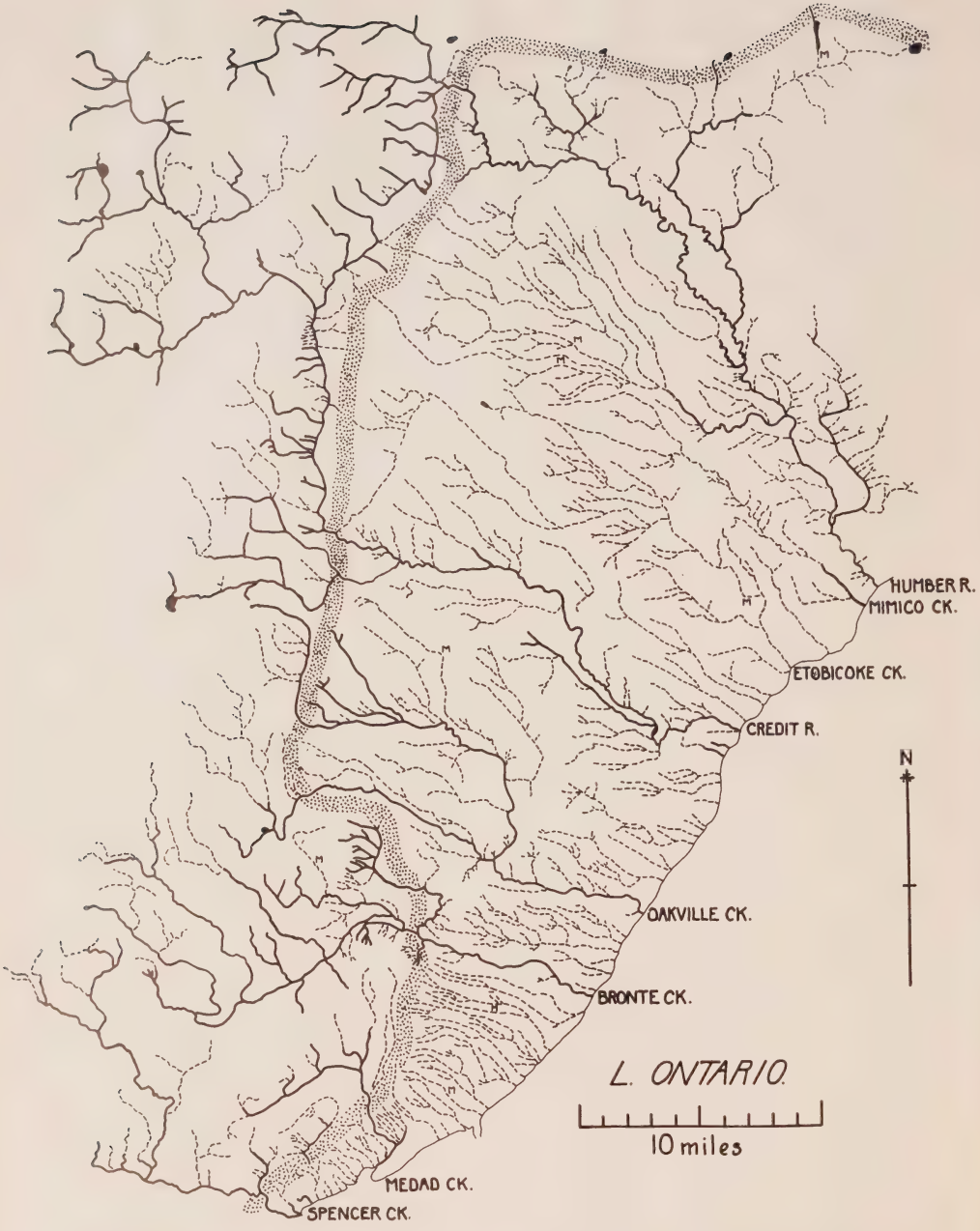
For some time there has been a growing realization that the water situation of Ontario is now unsatisfactory, created by a variety of experiences. The swimming hole might no longer be deep enough, or indeed might dry up; there might no longer be desirable fish, where once good sport was to be found; the mill might have to work short hours through insufficiency of water; a stream might show unpleasantly obvious evidence of heavy pollution; or springs and wells might fail which used to give abundant supplies.

There was, however, little exact information till the survey by K. M. Mayall of King Township in 1937. Among many interesting things he found that in 100 years—the span of agricultural development in the township—seven eighths of the 200 miles of its once permanent streams had become intermittent, failing in summer; and 17% of the wells failed, while others were reduced in flow.

Very similar figures were found to hold for the 1500 miles of water course in the Peel Plain and adjacent highlands.

	Streams				Uncleared land	
	Miles permanent	Miles temporary	Total	% temporary	brush etc. %	swamp %
Upland	321	199	520	38	23.3	
Lowland	178	837	1015	82	10.5	
Total	499	1036	1535	Mean...67%	Mean. 15.4%	

The map does not reveal the whole story, for it shows all permanent streams as the same size, which they are not. It is to be noted that those streams in the plain which are permanent do not rise in the plain; they owe their permanence to their origin in the less fully developed uplands; the plain, now very highly developed agriculturally, is no longer a nursery for useful rivers and streams.



Sketch map to show watercourses of the region west of Toronto, including Peel Plain and neighbouring areas. The broad sinuous dotted line marks approximately the limits of the Plain, on the west the escarpment of the limestone uplands, on the north the hills of the Interlobate Moraine. The lower land east and south of this boundary is more fully developed agriculturally than the land north and west of it. The streams shown by full lines flow all the year; those shown by broken lines are intermittent. Black spots are lakes.

Two pictures will illustrate the point; they show the Etobicoke Creek near Summerville in spring and in summer at a point where some 60 years ago there was a mill. A hundred and fifty years ago the Etobicoke was, according to a land surveyor of the time, "a rapid stream of water".

Further east Carman has shown that the upper waters of the Wilmot Creek have shortened; they start further downhill than they used to, leaving dead dry valleys above the present sources.

The more recent Ganaraska Survey (about which we are to hear) reveals similar bad conditions, and it is around the headwaters of these and neighbouring streams that some of the desert areas occur.

In Grey County, further north, it has been reported that now 75% of the streams no longer flow from ground springs, and that there is a seasonal water shortage all over the county.

All across the province the story is the same, varying only in details; from Maitland Creek, now sadly reduced from its former beauty, to the Grand River, now so incapable of maintaining sufficient flow to ensure the removal of filth that expensive treatment became necessary, past the Credit River, once a salmon river, but now lacking breeding places, for they are silted over—the list could be extended to the eastern end of the Province,—larger and lesser waters alike are in a decline.

Not only do the rivers fail; they often flood. The two things are indeed the opposite sides of the same bad penny; heads—drought, tails—flood, and in either case we, the inhabitants of the country lose. The water which is the floods of the spring thaw is a considerable part of what should be the summer's supply, going damagingly fast over the surface of the land to the nearest lake in a few wasteful days, instead of percolating steadily into the ground to replenish the vast underground reservoir, which is, among other things, the stabilizer of the streams, and which is the most important mass of water in the country.

The present state of streams and rivers is a symptom of much wider damage to the natural economy of the countryside. Practically all flood water is thick with sediment; it would probably cause us surprise if it were not, but it is in an unsound condition. It has been said by a member of the Soil Conservation Service of the U.S.A., that: "agricultural country with dirty streams is, must be, temporary; agricultural country with clean streams is, must be, permanent". A hard saying, but one that is worth our close attention.

There are none too many figures of the amount of sediment thus carried down by the rivers to be deposited where it is of no further use to man on the bottom of our lakes. In a high flood on the West Humber River, some 2,000 tons an hour were going past; I hope more

Photograph by A. F. Coventry.

Much of the rapid run-off which contributes to flood conditions in Southern Ontario rivers comes from severely eroded land at the headwaters—clay gullies in Peel County.

figures on this important point may be contributed in the discussion to follow. It is to be noted that while some of this sediment is carved from the banks of the river, some—the amount varies with local conditions—is the fertile top layer of land under cultivation.

I know of no published figures for Ontario of actual amounts of topsoil thus lost to farmers by uncontrolled—and in some cases actually encouraged—rapid movement of water over cultivated land; there are abundant figures for the U.S.A., and I give one diagram as an example. The figures would almost certainly be less for a corresponding site in Ontario, but they would not therefore be negligible.

There is another type of soil loss associated with the unbalance of our water—that due to wind action, and in some localities it is probably greater than the loss through the action of water; it can only occur on dry soils, and is most marked on light.

The stumps shown in the picture occur in the desert of two slides back, and about 4 feet of soil has been blown away in some 80 years.

Since there is to be a discussion on soil later in the conference I must not expand the subject here; I just note, with emphasis, that present soil losses, whether by gullying, by rilling, by sheet erosion or

by wind, in all their forms—these are important reasons for river valley development and control.

Along with failing rivers we have failing wells. City folk are not perhaps so conscious of this as country-dwellers; if water comes from a tap practically unfailingly at demand and with no labour, it is easy to lose sight of the enormously complex natural water balance that must exist behind the immensely specialized work of waterworks engineers, and to forget that the city, no less than the country, depends on a healthy state of natural water supplies.

If the water comes direct from a well, whether it be pumped by power or by hand, any deficiency of supply is brought home immediately and if total failure imposes the chore of hauling water, its lack becomes a serious inroad on the elementary amenities of life, as altogether too many country dwellers have discovered in recent years.

We have almost no accurate information on this aspect of our water owing to our failure to collect systematic data.

It is clear then that the natural water system of southern Ontario has undergone a profound and deleterious change during the period of development of the land by white man.

We have drought in summer and floods in spring, and sometimes at other seasons; we have too much water when we do not especially want it, and not enough water when it would be most useful; and this unbalance is not only bad in itself, it is the cause of great expense to communities which are subject to floods, and of much loss of labour for those who have to carry water often for months on end. At the same time this water unbalance is causing us the loss of unmeasured amounts of fertile soil, which is one of the ultimate assets on which the prosperity of the country depends.

We may add too that this ill-health of the waters is reflected in our wildlife, both game and otherwise. Anglers, a considerable number of people from youth to age, year by year have more difficulty in discovering fish, and this in spite of persistent planting. All across the Province the story is the same; old maps show salmon rivers and elder members of the community recall trout streams where now are polluted and shrunken and overheated trickles, or no streams at all.

And since the state of the land is so closely bound up with the state of the rivers, land game is less available than in earlier days; the habitats are no longer as extensive as formerly; and since a proper proportion of game habitats is an essential feature of a healthy countryside. quite apart from the game, the present situation cuts two ways, it indicates an unhealthy land and at the same time the pleasures of living in the country are reduced.

The same general argument applies to such fur animals as used to be available in southern Ontario.

Photograph by A. R. A. Taylor.

There is another type of soil loss associated with the unbalance of our water—that due to wind action and in some localities it is probably greater than the loss through the action of water. The Interlobate Moraine in Durham County, Ontario.

The proper treatment of wildlife and its relation to other aspects of the life of the community is an important consideration in river valley management.

If, then, we are to cope with the process which is going on we must look for the cause.

It is to be found in the *Hydrologic cycle.* This familiar diagram shows—in a simplified fashion—what can happen to water as it comes to the earth's surface and leaves it again in its constant circulation. It may follow many paths, some useful to man, some indifferent, some actually injurious. The amounts following the various paths will differ according to the nature of the country. In aboriginal Ontario they were determined by the forests which covered most of the land, so that there was little or no bare surface. Under the trees was a litter, a mat of twigs and leaves; the soil was penetrated by roots living or dead; and the movement of the trees by the wind kept open cracks deep into the earth; and frost did not bite so deep as into exposed land.

Under these conditions water on the surface, whether from melting snow or from falling rain, could not run off fast, it was held to saturation point by the litter on the surface and could find, even in spring,

many entrances into the deeper layers of the soil; it therefore arrived in abundance at the great underground reservoir, which could thus maintain the springs and streams of our early well-watered condition.

There could be no erosion, no soil loss, because the whole surface of the land was protected.

Now, it was of course entirely necessary that some of this land should be cleared for agricultural use; it was entirely natural that the abundant trees should be used for lumber and firewood; but the process of clearing was carried out so energetically in all its forms that it brought into existence the evils with which we are faced today. I do not know that we can greatly blame our forbears for the heavy burden they have bequeathed us; they hardly had the knowledge to be able to foresee the outcome of their stripping of the land of cover and of the use of agricultural methods not well adapted to the land and climate. It must, however, be admitted that rather more than a hundred years ago a New England farmer pointed out the inevitable decay of the countryside if the then-used practices were continued. They were continued.

In southern Ontario we have removed too high an acreage of trees; up to date figures do not appear to exist for more than a few small areas, but it is probable that 5% is a near guess at the amount of southern Ontario now under trees, i.e. about a fifth of the necessary minimum; in many counties the figure is less than that.

The rest of the land has been exposed for cultivation, and as we have seen, the relation of such land to the water balance is very different from that of the original set-up.

We have not been willing even to leave marshes as reservoirs; we seem to have had a, perhaps unspoken, slogan: "if you find a marsh, drain it"; and the result has not always been happy.

Marshes are often a most important factor in maintaining a healthy water balance; this is especially true of those at relatively high altitudes. The most famous of these is—or was—Luther Swamp, a sort of gigantic sponge 1,500 feet above sea level, in which accumulated to saturation, meltwater from snow and rain were fed evenly down streams in all directions. It is now seamed with ditches which ensure the rapid removal—as floods—of these waters to the consequent detriment of rivers which take their birth in it. The dam near Fergus is one result of the draining of Luther Swamp.

I am told that still more draining of high-level swamps, also contributory to the Grand River, is in progress, and the map confirms this, a process that can only accentuate the troubles we already have.

This is merely an example of a general tendency, and it is a thing which must be most carefully considered in preparing river development policy.

To sum up: practically every phase of the development of southern Ontario has contributed to destroy the natural balance of water. We have removed too many trees, even from lands fit for agriculture; we have taken no significant steps to replace trees on large areas which by their nature can grow no other crop (some 8,000 square miles in all); we have cultivated the land in such ways as to encourage the loss of essential soils and water; and we have failed to realize the value of swamps and ponds.

The fact that we share these sins of omission and commission with many other countries does not make our present burden any lighter, nor diminish our responsibility for doing all we can to remedy the situation. It cannot improve itself; it will on the contrary get progressively worse. To land already waste will be added year by year more waste (how fast is, I think, not known, but in one county some two square miles, about 1,300 acres, slip out of productivity each year and become incapable of further cultivation).

We all know of the disaster of the Prairie Provinces, and are apt to look on it as a special and terribly severe case; it has, however, been estimated by a competent authority that, bitter as was the suffering in the west, there has been east of Winnipeg, as the result of the degradation of our natural resources, just as much suffering and waste of human effort as there has been west of that city. The full toll is not so obvious, because it is not so concentrated, but it is there and Ontario has its share.

We are "half living in a half-living land", as a recent author puts it; our decreasing rural population shows it, and comparison with say Denmark—of course before the war—confirms it. It is perhaps worth noting here the frequent statements that we are to have a much increased population after the war; the estimates vary widely, from 8 million to 25 million for Ontario (2 to 6 times the present population); but it is probably true, however unpalatable, "that a sufficiently large population to make Canada fully prosperous could not now be maintained upon our present resou rces unless an entirely new policy is adopted towards them."

I have stated the case for river valley development; it is either development or degeneration.

The cheerful side of the matter is that, given the will, a very great deal can be done to restore not former conditions—for we do not want to re-forest all southern Ontario—but a balanced and healthy countryside better able to maintain a good human population than at present. The methods are known and have been applied very successfully elsewhere; they can be applied here if we get a clear understanding of what is to be done, and do it.

What river valley development means is the restoration and preservation of all the natural resources of the river valley, for they are all inseparable parts of a total balance, and cannot profitably be managed piecemeal.

River valley development begins before the water reaches even the ditches; it begins by encouraging water to soak into the land instead of being hurried off as fast as possible to the nearest ditch; that is the time to control waters, before they have gained momentum and while they are on the land where they can play their proper part in the maintenance of the essential water balance.

This of course raises some problems of drainage, of the need of getting water off some kinds of land so that they may be available for cultivation at an early enough date. The need cannot be denied, but it does not follow that the only way to get water off a piece of land is to conduct it as fast as possible to the nearest river. It may be led by very gentle gradients to gently graded and properly protected ditches and in many cases it could be stored in ponds on low areas of land, where it would have a chance to percolate into the soil, and where it would be, at least for part of the season, a water supply; it has been shown, moreover, that if such ponds can be made permanent they will raise important quantities of edible fish.

In some parts of France water culture is regularly alternated with field culture as part of the normal management of farms, the location of the ponds being altered every few years, with the old ponds coming under productive cultivation as they are drained.

These procedures hold up water on its way to the streams and tend to make its influx more gradual and so more manageable; it is in the little streams—after the surface itself—that floods are best controlled.

Here in the little streams before they come together to make the larger river, more ponds can be created by the generous use of small dams wherever the configuration of the countryside allows; these will again be useful as stock-watering ponds, and in some cases will replace a lost swimming hole, and perhaps become the central feature of a park, to the improvement of the amenities of a community. They will hold back some of the always over-abundant water supply of the season of thaw and allow still more water to get underground.

With these control measures about the headwaters, control of the main river becomes much easier, and to them will of course be added other methods of control, such as reforestation of suitable areas, special crops, development of pastures, and many minor procedures.

This view of river valley development obviously puts the task largely on the individual; and indeed he is by all odds the most important factor; unless the inhabitants of the valley take their personal shares in the business the job can never be properly done. It is a

Photograph by A. F. Coventry.

We have floods in spring and droughts in summer and too much water when we do not especially want it, and not enough water when it would be most useful; and this unbalance is not only bad in itself, it is the cause of great expense to communities which are subject to floods, and of much loss of labour for those who have to carry water often for months on end.—The Etobicoke River near Summerville in flood.

co-operative undertaking, going forward according to a plan for the whole valley, a master-plan to ensure that all the separate things that are done shall fit into a harmonious whole working with nature and not against nature as most of our so-called development has hitherto done.

Planning has been a good deal misunderstood and the idea has aroused antagonisms which are not justified. We know that natural resources are inter-related and form a complex balanced system, and that the disturbance of one element affects the others: we have seen what unplanned exploitation has made of our natural resources, notably of water; and it is clear that if we are to restore them we must do so in an orderly fashion, i.e. we must plan.

It is impossible to run a factory without planning. If the activities of one department were not co-ordinated with those of all the others, confusion would soon put an end to the business: much more is planning needed to ensure that our natural resources, now badly out of gear, are brought into working relations with each other again, for they are far more complex than any business, even the biggest.

It has been objected that planning interferes with the liberty of the individual, in which we properly take pride as an essential part of our way of life; but even in our way of life there must be some restrictions and some commands, they are inseparable from membership in a community. Under any plan there must be some giving as well as taking, and whether the compulsions of a plan voluntarily agreed on for the general good of the community are preferable to the harsh compulsions of run-down land or the inexorable penalties of outraged natural laws may be a matter of opinion; but that is the choice.

Planning can, I think, be worked out within a fully democratic framework. I do not say it is simple or easy, but neither is the problem. Progress depends on an ever-widening public appreciation of the need of conservation, so that in time a considerable proportion of the population will come to the conclusion that "something must be done about it". If the conviction is strong enough to go beyond talk, it is the starting point of action.

Those interested will agree to co-operate for the common benefit, realizing that public interests must be given a generous place alongside private rights; that there must be yielding of privilege here and there, that the condition of the community as a whole shall be bettered, with, naturally, a consequent improvement in life of the individuals composing it.

There is no compulsion save that of conviction; those who do not like the scheme can stay outside.

The Etobicoke River near Summerville in summer.

Photograph by A. F. Coventry.

Such planning then develops from the region upwards: local conviction of need inspires local decision to act, and the steps of action might be somewhat as follows:—

(1) The formation of public opinion that local conditions would bear improvement;

(2) Widespread recognition in the district that it is possible to bring about improvement by co-operation, if enough of those who live in the district are willing to take part in planned management of land under their control;

(3) Voluntary agreement of a considerable majority of those concerned to abide by the procedures laid down in a carefully prepared plan;

(4) A request to the Provincial Government to authorize the formation of a conservation district (to give it a convenient name) and to help in the planning by providing the necessary expert advice and surveys, to work in conjunction with the local people. This will produce a master-plan which shall serve as guiding principle for action;

(5) Implementing the plan.

A programme of this kind is easy to talk about, but in realizing it many troublesome problems may arise, and to solve them will call for the fullest understanding of the meaning of river valley development and a large measure of goodwill among the participants in the undertaking. For example:—the control of work done on private land at public expense; doubts as to the reasonableness of asking folk at the mouth of a river liable to flood to bear part of the expense of, say, planting protective trees on someone else's land miles upstream; questions of the right of a landowner to build dams across a stream which traverses his land on its way to many another man's land; or the right of an owner to cut clean his woodlot, even if its removal will imperil the permanence of a stream and perhaps the livelihood of people downstream (I have in mind a case where this actually happened).

River management is not a matter for urban centres alone, nor for the rural parts alone: each has it special and proper claims on what the river has to offer, and those claims must be reconciled by discussion and agreement to the greatest general benefit. If purely sectional interests prevail, the odds are long against permanent restoration and conservation.

If development is to be effective, the unit of development will have to be the whole river basin, and this will often extend over several administrative areas as at present set up: again mutual understanding and co-operation will be essential, for nature takes no account of the straight lines which the T-squares of early engineers imposed on our country.

If we are to develop our rivers so that once again they play their proper part in the life of the modern communities in their valleys we shall have to bring into action all the knowledge we have or can obtain on all our natural resources, for unless all are carried along together something less than the best results in development will be achieved.

This is a big job, but fortunately for us in Ontario few of the river basins we are concerned with are really big; their areas are in hundreds rather than thousands of square miles, but taken together they comprise the whole countryside. Each is a project worthy of the best attention of its inhabitants, and in each the method of going about the job is the same—co-operation all along the line.

Success will only be reached if some long-established ideas are modified and some old practices abandoned; but we are in an age of changing ideas and new methods and there is this to be said—river valley development is not a theory; it is not an empty dream; it is a dream which can be made to become alive; much experience, especially in the U.S.A. has shown this over and over again: what is more, it is not a long time before important results appear; the great mass of restoration, several times the area of southern agricultural Ontario, has taken place within ten years.

That I think is in brief the general case for river valley development in Ontario, especially in the south; and the rather grim facts on which it is based form the inescapable background to this conference.

DISCUSSION

DR. J. D. DETWILER, UNIVERSITY OF WESTERN ONTARIO, LONDON: The last speaker has told us of our lack of any definite information on our erosion problem. This is all too true. We can't blame the Government for that. We have to reflect on our scientific curiosity.

I think it was in 1941 after a spring rain, the Thames was flowing quite muddy. Being curious I took some samples of the water and made a determination on the amount of soil that was running down the stream. In my determination I found that in every 24 hours enough soil went down to remove one-quarter of an inch from an 100-acre farm.

Now, the Thames River Valley is not one of the bad ones for erosion. It is bad enough. The Grand River Valley is worse.

I wanted to give this information because it fits in with what we have just heard. It is a little information we have. It is very difficult but I think what we want to get hold of is more information. We have heard a lot of talk in generalities. What we want I think is accurate information and figures.

CHAIRMAN LANGFORD: I am not surprised that there are not many who have comments to make after this paper because Professor Coventry, with his usual ability, has painted a very complete picture. As he himself pointed out, it is rather a grim one. Most of us here today appreciate some of the facts which he has so pointedly put forward. Perhaps we don't all realize what can be done about it. So we have arranged to have someone here today who can give us some indication of what can be done with these desperate cases that we have heard about.

3

THE STORY OF THE MUSKINGUM PROJECT

Bryce C. Browning
Secretary Treasurer, Muskingum Watershed Conservancy District,
New Philadelphia, Ohio, U.S.A.

HISTORY indicates that human progress has always been closely related to the extremity of man's need. In a study of typical examples of such progress, we find that there is first a recognized need. Then comes vision or a realization that a solution of the problem is possible. Then through competent leadership, a plan is evolved. Following completion of the plan, a means of execution is found.

Of these three basic requirements, — need, vision and a plan, — vision is unquestionably the greatest.

Flood control is a typical example of this truism. Thirty-two years ago, the words "flood control" had little significance. With the exception of a limited amount of channel improvement work, such as had been constructed in the Mississippi River and its tributaries, there was perhaps no engineering project in the United States that might properly be labelled "flood control". Even the few channel improvement jobs had been justified on the basis of navigation benefits rather than flood control.

It was almost thirty-two years ago, in March, 1913, that the state of Ohio was subjected to its greatest civilian catastrophe. Within the course of a few hours, through the great flood of that period, 400 lives were lost, $400,000,000 of property was destroyed and secondary damage of perhaps as great value was sustained. Immediately, throughout the State, there came a realization of the desperate need for flood control.

In the City of Dayton was found the right combination of factors to produce results. First, that City's loss in lives and property had been greater than in any other Ohio community. Second, within that City was centered some of the ablest leadership and engineering talent to be found in America. Finally, it was a community of ample financial resources. Even before the flood waters had reached their peak, men of vision were saying, "This must never happen again." "We must find a means of controlling destructive floods." Within a few weeks a fund of more than $2,000,000 had been pledged for the specific purpose of accomplishing such a result. This permitted the employment of the world's ablest hydraulic engineers to study the problem and suggest possible answers. Included in this group was Dr. Arthur

E. Morgan of Memphis, Tenn., whose previous experience had been limited primarily to the field of drainage engineering.

While the possibility of controlling floods through source stream regulation had been suggested at various times in the past, few people regarded this method as being practical. It was the general opinion that the only possibility of flood control for Dayton was through the providing of a much greater stream channel. However, when the plans suggested by the various engineers were considered, it was found that Dr. Morgan proposed protecting the community through a combination of flood storage reservoirs plus channel improvement works. Perhaps, due to the unusual vision of the committee representing the City, this plan appealed to them and he was engaged as the Chief Engineer to develop such a flood control program.

One of Dr. Morgan's early discoveries was that source stream flood control did not lend itself to the type of political subdivision in Ohio. In other words, the boundaries of cities, towns, counties or townships, did not follow the outlines of river systems. The conclusion was thus reached that a new type of political subdivision, whose boundaries might be adapted to the drainage area to be controlled, must be created. This, in turn, necessitated the passage of new State laws. Fortunately, the then Governor of Ohio was a citizen of Dayton. In addition, he was a man of vision and ability. Through Governor Cox, the State Legislature was called in emergency session and the Ohio Conservancy Act was born. Under its provisions, the Miami Conservancy District was created and the Miami Flood Control Project completed. After some 25 years of testing, it has proved itself to be the answer to the flood control needs of that important industrial and agricultural community. This same Act, with slight modification, has been used as a model for flood control legislation in other states.

In analyzing the development of the Miami project, we find first, a recognition of great *need* for flood protection. Then came a *vision* of the possibility of flood control. This was followed by a working *plan*, and, with the execution of this plan the problem was solved.

While there was great property loss in the Muskingum Valley of Ohio, particularly at Zanesville, as a result of the 1913 flood, the preventing of future floods there represented a far greater problem.

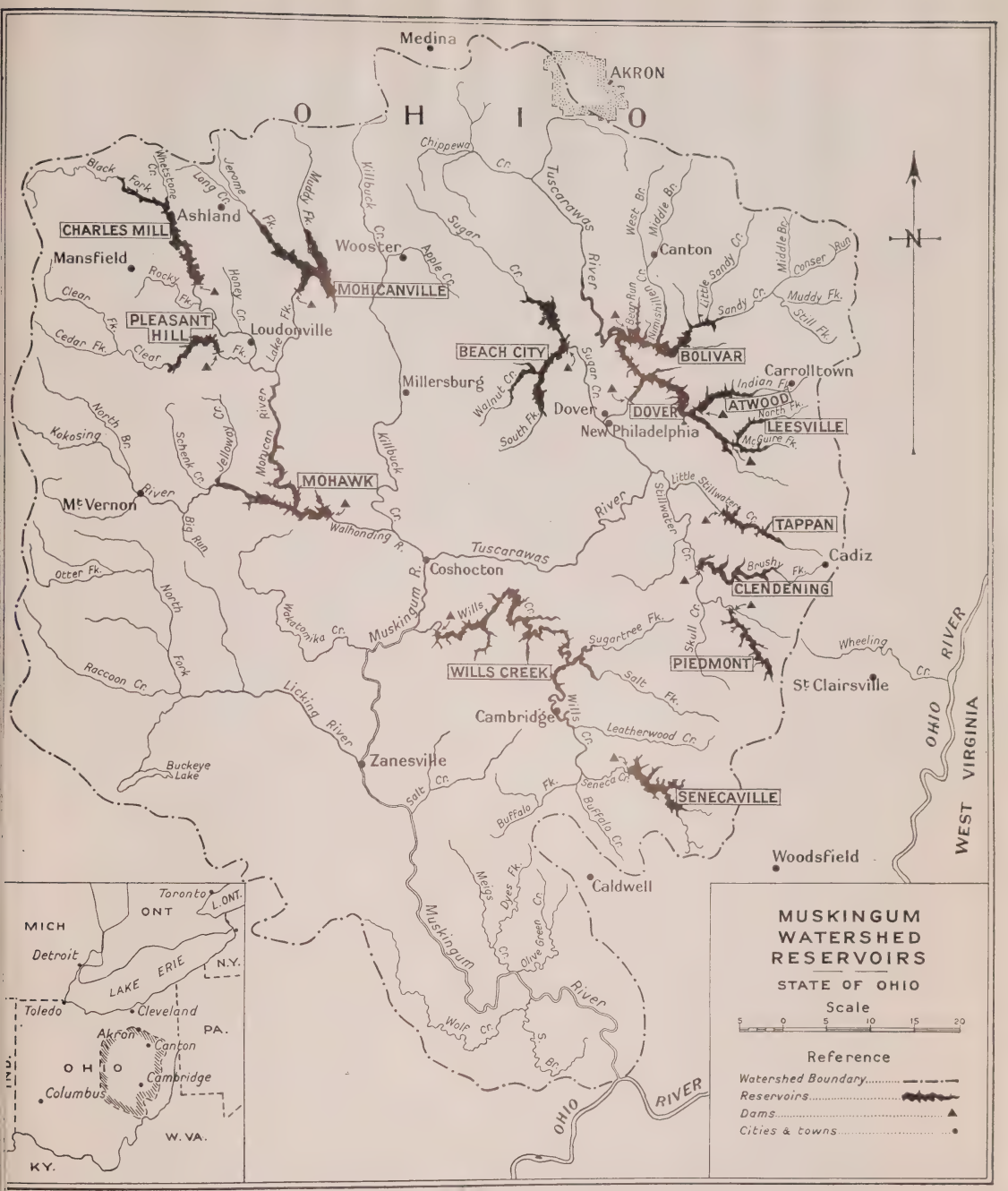
The Muskingum drainage area was approximately double that of the Miami but, due to more limited industrial development and less valuable agricultural lands, the property values were not nearly so great. While the people of the Muskingum Valley felt the same desperate need for flood control, the problem seemed too great and not until almost 15 years later did they reach the vision or plan status.

It was in the fall of 1927, someone suggested to the people of Zanesville that major floods in the Muskingum Valley had been occurring in 14 or 15 year cycles. At the time their city was being subjected to a period of intensive rainfall, the river was rising, and suddenly, the people again became conscious of the great need for protection. As a result, some $2,500 was quickly raised and the Dayton-Morgan Engineering Company, of which Dr. Morgan was the head, was employed to make a preliminary plan or survey of flood protection possibilities.

Some six months later the study was complete and Dr. Morgan made a personal report to the people of Zanesville. It seemed discouraging in that it indicated the impracticability of flood control for that city except as the people's vision was greatly broadened. There were three distinct suggestions, each of which seemed startling from the standpoint of the thinking of local people. He first stated that complete flood control for Zanesville was financially impractical except as the programme was broadened to include the flood control interests of the entire Muskingum drainage area, about one fifth of the State. Secondly, he suggested that flood control was a matter of State and Federal, as well as local interest, and that both the State and Federal Governments should participate in any adequate plan of flood control for the area. Finally, he proposed that any such plan should include, not only flood control but water conservation, navigation, recreation or any other engineeringly sound objective which might be successfully associated with the basic flood control need.

When Dr. Morgan's report was made, the immediate flood hazard had long since passed, the sun was shining and interest in flood control was at a low ebb. Actually, there were fewer people in attendance at the meeting which he addressed than had served as solicitors for the flood control fund some six months earlier. Under the circumstances, it still occasions wonder that the people of the community went any further with the program. However, the flood control committee determined that efforts should be made to broaden the objectives as proposed in the report.

In 1930, Ohio suffered the greatest drought in its history. For a period of more than six months there was practically no rainfall. Springs, wells and streams dried up over much of the area and there was critical suffering throughout many communities. In numerous instances, municipalities were in desperate straits because of the lack of water. The resulting damage went into hundreds of millions of dollars. This condition seemed to offer the needed opportunity for the broadening of the original Muskingum flood control program. Within a limited period, a new association was organized which embraced all the communities within the main drainage area of the Muskingum. As a result of their efforts, the State of Ohio appropriated



The Muskingum Watershed Conservancy District, State of Ohio, U.S.A., showing its relationship to Southern Ontario. Area in square miles of watersheds above the dams indicated are as follows;

Charles Mill, 216; Pleasant Hill, 199; Mohicanville, 269; Beach City, 300; Bolivar, 502; Dover, 1,397; Atwood, 70; Leesville, 48; Mohawk, 1,501; Tappan, 71; Clendening, 70; Wills Creek, 844; Piedmont, 84; Senecaville, 121; Total Area of Muskingum Watershed 8,038 square miles.

$10,000 to assist in a more detailed survey of the flood control and water conservation possibilities. This report, which involved approximately a year of study, again emphasized the necessity of a broad co-operative effort. In the meantime, the U.S. Corps of Engineers, under authority of Congress, had been making a study of the Muskingum drainage area from the standpoint of evolving a possible flood control plan.

In 1930, the Zanesville Chamber of Commerce employed, on a part time basis, one of America's pioneer conservationists. A man who should go down in history as one of its greatest benefactors in that field. This was Mr. George H. Maxwell. A native of California, Mr. Maxwell had been pioneering conservation works for nearly 40 years. Among his outstanding accomplishments had been the organization of the National Reclamation Association, the passage of the National Reclamation Act and the initiating of construction of the Roosevelt Dam and other Western Reclamation Structures. In 1912 he had served as Executive Director of the Pittsburgh Flood Control Commission and had proposed a plan of flood control for that area which involved the use of source stream reservoirs. However, this plan had been so ridiculed by certain engineers and so opposed by selfish interests that no real results had been attained.

Mr. Maxwell had been carrying on what was largely a one-man campaign for the establishment of an adequate water and soil conservation policy in the United States. For many years it had been his contention that flood control in the Mississippi could only come through the establishment of source stream regulation. It was his belief, also, that the Ohio River was the most important Mississippi tributary from a flood control standpoint, and that the original flood control works should be located there. Further study of the Ohio drainage area had convinced him that the Muskingum was perhaps its most important tributary, from a flood control standpoint, and that it would be the logical place to start construction of a flood control program for the Mississippi drainage area.

It was under these circumstances that Mr. Maxwell co-operated with the Zanesville Chamber of Commerce in its conservation efforts and, for several years, carried on an intensive conservation education program in that community. As a result of his efforts, the people of the community were perhaps the best educated of any in America, from the standpoint of the problems of water and soil conservation. Through his teachings, there was a general consciousness that the major problems of the community were related to water; that uncontrolled water was primarily responsible for their critical soil depletion problems; that this same uncontrolled water produced not

Muskingum Conservancy District Photograph

Leesville Reservoir showing earth dam, gate house, caretaker's residence, part of lake and topography of surrounding country.

only floods but was responsible for the critical consequences of droughts; and that all these problems might be largely solved through the establishment of a complete program for the slowing up of the water run-off.

Under the inspiration of Mr. Maxwell's teaching, various conservation leaders throughout the United States became interested in the Muskingum Project and visited the area. Among these authorities was Dr. Hugh H. Bennett, who later became chief of the U.S. Soil Conservation Service and whom some of you know personally. With Dr. Bennett's assistance, one of the early soil erosion demonstration stations was stablished in Muskingum County near Zanesville. As a result of this early association, Dr. Bennett's interest in the Muskingum Project was developed and has since continued.

It was in 1933, in the midst of the great depression, that a newly elected President of the United States proposed a Public Works Program and suggested the establishment of flood control works in the

Ohio Valley as one of the objectives to be attained. He, likewise, proposed numerous other conservation projects, practically all of which had been promoted by Mr. Maxwell throughout the Muskingum Valley during the preceding years. It being the opinion of the promotors of the Muskingum Project that an agency of State Government, comparable to the Miami Conservancy District, would be of great assistance in dealing with the Federal Public Works Administration then being created by Congress, plans were immediately started for the formation of the Muskingum Conservancy District. This District, as established, embraces practically the entire Muskingum Drainage Area of 8,038 square miles and includes all or parts of 18 Ohio counties.

While one group of citizens was going forward with the organization of the Conservancy District, another group travelled to Washington and endeavoured to interest the Public Works Administration in the Muskingum Program. Fortunately, the proposed Muskingum Project, involving flood control, water and soil conservation and recreation, was of unusual interest to them. From the beginning, the sponsors were encouraged to believe that the Project would receive approval. Actually, it was not until some six months later, in December, 1933, that funds were allocated to it.

Under the policy generally followed in the first Public Works appropriation, Federal grants represented only 30% of the total cost of approved projects. Due to the type and size of the proposed Muskingum project, this was entirely inadequate and much effort was expended before agreement was finally secured to a greater allocation. Under the terms of the final contract with PWA it was provided that the United States should pay the entire construction cost including all utility relocations, except highways. It was the responsibility of the District to provide all the necessary lands, pay all damages and to relocate all affected highways. It was the estimate of Conservancy District Engineers that the highway relocations would represent a cost of some $6,000,000, and the lands and damages a cost of approximately $8,000,000.

At the time this proposed contract was approved by representatives of the Conservancy District, it was realized that it represented a far greater cost than could be absorbed by the benefited property owners. It was felt, however, that the State of Ohio should be willing to assume a portion of this burden. Fortunately, Governor White, was a resident of the Muskingum Conservancy District and greatly interested in the proposed program. At the request of officials of the District, his approval was given to the consideration of appropriations to the Muskingum District at a special session of the State Legislature. Following an intensive educational campaign, the Legislature, by

almost unanimous action, made a cash grant to the District of $2,000,000 and authorized the State Highway Department to take over the cost of relocating all the affected roads and highways. This left the District with a burden of some $6,000,000 to absorb.

Under the provisions of the Ohio Conservancy Act, an appraisal of benefits and damages resulting from the proposed project was completed and an assessment of 50% of the benefits made against the flood protected properties. Bonds were promptly sold, based on these assessed benefits and, with the assistance of the funds provided by the State Legislature, the acquisition of the necessary lands was undertaken.

While the program proposed by the citizens of the Muskingum area largely embraced the teachings of Mr. Maxwell, the authority of the Public Works Committee, who considered the Muskingum Project, was limited to flood control. While this Committee gave their approval to the entire program, it was impossible for them to allocate funds for anything but flood control and water conservation. It was their proposal that the District endeavour to co-operate with the various agencies of the Federal Government which had been set up to administer the broader conservation program. It was under these circumstances that very close and friendly relations were established with the U.S. Soil Conservation Service, U.S. Forest Service, the Works Progress Administration, the Civilian Conservation Corps, the National Youth Administration, the National Park Service and various other Federal agencies, as well as with the different State Agencies having authority in the field of conservation.

It is the opinion of many so called authorities, that the Muskingum Project is one of the most interesting co-operative developments in the history of the United States. The basis of this opinion is the fact that it represents the first instance where both the Federal and State Governments have co-operated with a local unit of government in the financing and construction of a broad conservation program. There were some 20 Federal, State and local agencies who co-operated actively in this development. Students of law were particularly impressed with the project inasmuch as it demonstrated the practicability of such co-operation. While several of the agencies no longer exist, the District's office at New Philadelphia still houses representatives of 6 different co-operating divisions of Federal and State Government, in addition to its own staff. Other agencies were so housed prior to the war emergency and it seems probable that they may again be active in the Muskingum program in the post war period.

While the basic purpose of the Muskingum Project was flood control, it seems probable that succeeding generations may think of it,

Muskingum Conservancy District Photograp

The State of Ohio lacks natural lakes of good size. The large reservoirs, such as the Seneca shown above, are intended to serve also as recreation centres including boating, fishing, cottage sites, etc.

primarily, as a land conservation and recreation program. Despite the war emergency, its lakes will have been visited by more than one and a half million people during the present year. This represents an increase of some 25% over last year and of 50% over the year 1942. It is generally believed that the broad program of recreational development associated with the Muskingum lakes, and which should be developed in the post war period, will make these areas Ohio's greatest recreational asset. The water areas include 10 permanent lakes totalling 16,000 acres, surrounded by some 50,000 acres of District owned lands.

While the acreage of land to which the Conservancy District holds title is extremely small as compared to the more than 5 million acres within its boundaries, it has afforded an opportunity for a broad and well balanced conservation development. Located in the Eastern section of Ohio, the District is in the so-called hill land area. This area has been subject to many years of critical soil erosion and has reached the point where much of it is no longer suited to

normal agricultural operation. Surveys made by farmers in the various counties, with the assistance of competent representatives of State and Federal Agencies, indicate that approximately 50% of the total area of the District is suited only to forest development.

Unfortunately, the great cost of planting trees, the critical fire hazard and the long period necessary to produce a crop have tended to discourage tree planting by farm owners. It is the opinion of officials of the Conservancy District that one of its greatest responsibilities is to set a good example of land conservation. For this reason, the District has carried on a program of tree planting under the direction of foresters provided by Federal and State Agencies. One of its principal objectives has been to devise new and more practical methods of tree planting. Based on this experience, trees are now being planted on contour ridges prepared some 6 months in advance of the actual planting period. This has resulted in an increase of approximately 100% in the speed of planting, has reduced the losses to less than 50% of those normally anticipated and has almost doubled the growth during the critical 3 or 4 year period following planting.

At the present time, representatives of the District are working with leading agricultural implement authorities in an effort to develop a type of machine which will prepare these contour ridges in the best and most economic manner. Because of steep slopes and the prevalence of rock, briars, brush, stumps and similar impediments, any normal method of plowing has been found somewhat difficult. The proposed implement involves the use of discs and will make it possible to prepare a complete contour ridge approximately 4 feet in width, in a single operation. Study is also being given to the possibility of developing a machine which will plant the trees in this prepared strip. The steepness of the slopes and the type of soil material tends to make this difficult, although it is believed the task is not an impossible one.

Officials of the District have been amazed at the interest shown by individual farmers in this tree planting program. It is their opinion that, with the development of improved machinery and more effective co-operation on the part of the State and Federal Governments, it will be possible to quickly re-establish desirable forest cover in the large area of Eastern Ohio, which requires such treatment.

In the meantime, the Ohio Division of Forestry has established the Conservancy District as a fire control area. Under the direction of competent, full time, supervisors, several hundred farmers throughout the District have been designated as fire wardens and are supplemented by volunteer organizations of Boy Scouts and high school students. Because of inability to purchase fire towers, an aerial fire patrol is maintained throughout the fire hazard season. The home of each of

the fire wardens is indicated by a large painted numeral located on one of its outbuildings. In this manner, the location and identity of each of the wardens is visible to the patrolmen and fires are reported through the dropping of messages.

In that portion of its lands suitable for normal agricultural operation, the Conservancy District is working closely with the Soil Conservation Service in establishing the most desirable program of farm operation. The war emergency, with the resulting difficulty of securing adequate supplies of fence, so essential to the laying out on the contour, of hill farms, has delayed completion of this program. However, studies have been completed of all farm units and, as quickly as possible, each one of them will become a demonstration of the newest and best methods of agriculture.

Under authority of an Act of Congress passed in 1939, the War Department has assumed responsibility for the operation of the flood control works of the District. This was in keeping with the Federal policy established the previous year. Under the terms of the agreement reached between the War Department and the District, the operation of the Reservoirs is in accord with the Official Plan of the District. The District holds fee title in all lands except those occupied by the dams and is responsible for all phases of the project except flood control. Since that date all operating costs of the Conservancy District are paid from income.

During the calendar year 1943, the District's income from agricultural operation was approximately $75,000. The bulk of this came from farm rentals, sale of crops, including timber, and from mineral rights, primarily oil and gas. While the charges made are quite modest, the District's income from recreational sources during this same period was over $40,000. On the basis of available figures, due to a less favourable crop season there will be a decrease during the present year in agricultural income but this will be more than offset by that received from recreation.

As the war has prevented the development of any but very limited recreational facilities and made impractical the leasing of cottage sites, it is anticipated the recreational income should be more than doubled in the post war period.

In conclusion I can only repeat, that, where there is a great public need and the people have vision, a workable plan for the correction of the condition must surely follow. The execution of such a well planned program is then only a matter of time and opportunity. I know of no better illustration of this fact than the experience of the people of Ohio in the Miami and in the Muskingum Conservancy Districts.

DISCUSSION

MR. W. RAYWOOD SMITH, LONDON: I noticed in Mr. Browning's remarks he starts out by saying the Conservancy work in Ohio was started by the passing of the Conservancy Act. Both the Miami and Muskingum works were based on the Ohio Conservancy Act and I feel that our Resolutions Committee has a little job on its hands, namely, to send a reminder down to the Government indicating that we need a Conservancy Act in Ontario.

MR. HERZ, WATERLOO COUNTY: In Mr. Browning's talk he spoke about reforestation by farmers. What assistance did their Association give the farmers? Were they provided with trees? Were they supplied with fencing? Was anything like that done or was it left to the farmer to do all that work?

MR. BROWNING: Primarily, it is a matter of planning, the providing of technical and engineering assistance, and, particularly, the providing of trees at no cost at all, or a very small cost. We feel we should go further and our plans contemplate the use of new machinery which we are developing and expect to make available to individual farmers on the basis, perhaps, that they will only pay the cost of gasoline, and in that way help them prepare the soil. We hope to be able to supply the trees they require. This will all be under provision of a contract that the trees will not be harvested until they are mature and that they will be fenced off so cattle will not graze on them.

MR. HENRY: Who does the fencing? Do you assist the farmers? We are interested in that kind of work ourselves.

MR BROWNING: On demonstration units the Soil Conservation Service actually provided fence in some instances, and aided the farmers in putting it up. Our Civilian Conservation Corps Camps helped with this work. In many instances, where it was found the farmer couldn't afford to purchase the fence, it was actually provided. That was only on the demonstration units. All the farmers received free trees, technical supervision and, in some instances, power equipment.

MR. HENRY: The development of the dams and lakes you spoke of—does the Association now own the dams and lakes?

MR. BROWNING: The United States now holds title to the dams. In other words, the ground the dam occupies has been conveyed to the Federal Government. The Conservancy District own all the other land. It has complete control over it, and the contract between the District and the United States provides that the flood control works must be operated in accordance with the official plan of the District. In other words, the War Department simply does the job we set out to do ourselves. In that way they relieve us of a sizeable maintenance cost and have eliminated the necessity of any local taxation for the operation.

MR. HENRY: May I ask one more question. In connection with that work there would no doubt be several small dams, just a few acres, or something like that—would that also be under the State development or State control, or with the owners to whom the land belonged?

MR. BROWNING: If I may be pardoned I will amplify a bit. The survey provided for thirteen control reservoirs. In addition to that there is a plan for some fifty smaller dams, primarily for water conservation purposes. The drought in 1930 frightened people. The ground water was going down and, in many instances, springs and wells were going dry. Our farmers were having to haul water and it was felt the head water reservoirs would be a desirable thing. Actually that part of the plan was never completed. It is ready for use and in the post-war period we expect that portion of the programme will go forward.

In addition we had another plan that provides for the construction of so-called ponds, or farm reservoirs on individual farms. That has been developed and carried on on a small scale by the Soil Conservation Service. It is all part of the general picture. We expect to have literally thousands and thousands of small reservoirs over the drainage area.

DR. OTTO HOLDEN: I understood you to say, Sir, that the Conservancy District had acquired some 50,000 acres of land outside of the land covered by the waters of the storage reservoirs?

MR. BROWNING: That is right.

DR. HOLDEN: I would be interested to know whether that additional acreage was acquired intentionally or whether it is just the left over part after securing the area of the reservoirs.

MR. BROWNING: It was acquired intentionally. You in Canada are blessed with beautiful lakes. We in Ohio have no natural lakes, if you think of natural lakes being of any size. It was the fear of the Board of Directors of the District that people who wished to capitalize on the public investment might acquire the land adjacent to the permanent lakes and get great sums of money for them because we will pay a lot of money in Ohio for land adjacent to a lake. So as a basic programme, the District determined it would acquire a minimum of 100 feet beyond the shore-line of any permanent body of water. Actually, our normal holdings will go back 400 or 500 feet. In some instances they go much farther. The farms being laid out on the square, the valleys winding around, we just can't follow them directly, but we have a minimum of 100 feet, and in most instances, 400 or 500 feet of land outside the permanent body.

DR. HOLDEN: That is just an evidence of the extent of your vision in planning this scheme. In regard to the operation of the reservoirs by the United States Corps of Engineers, does that operation also include the maintenance of the structures?

MR. BROWNING: Yes, all the maintenance cost.

DR. HOLDEN: And if I might ask one further question—do I understand in the operation of the various works there is a definite distinction drawn between the works provided primarily for flood control, and those provided for the conservation of water for low flow periods, or is an attempt made to use the main reservoirs for flood control and for the supply of water in low flow periods?

MR. BROWNING: Actually we have four reservoirs that are almost solely for flood control. We are in a highly industrialized district. It wasn't practical to get all the needed flood storage in these large reservoirs. That was in our favour because we had planned for the smaller reservoirs. Under the circumstances we went back into the headwaters and developed the additional reservoirs that serve to supplement the storage of the ones further down stream. The whole thing is co-ordinated to flood control, but there is only limited flood storage in the headwater reservoirs.

COMMANDER A. W. BAKER, TORONTO: In regard to assistance extended to private landowners for planting, is that extended irrespective of where the planting may be done, or is it extended only where you consider the planting is of immediate importance from the point of view of water control?

MR. BROWNING: It is extended to any resident of the district, in fact to any resident of the State, because the Soil Conservation Service and the State Division of Forestry do most of the work themselves. I tried to emphasize the fact that ours is a co-operating programme. We haven't tried to supplement the work of any other agency, that is to take over any of their work. We think—Dr. Detwiler will bear me out on this—we are the best co-operators in our country. We co-operate with anybody so long as they do their share or a little more. In that way the tree planting programme was developed. We are working with the State and Federal agencies on a plan to broaden the tree planting programme, particularly in the areas back of the reservoirs. This is available to any farmer in Ohio.

COMMANDER BAKER: No matter where he wants to plant the trees?

MR. BROWNING: That is right.

4

THE NEED FOR URBAN AND RURAL CO-OPERATION IN RIVER VALLEY DEVELOPMENT

W. H. Porter
Secretary, Ontario Conservation & Reforestation Association and Editor of the Farmer's Advocate and Home Magazine, London.

URBAN people have co-operated wholeheartedly with country folk in the exploitation and denudation of the countryside. It is only fair that both should co-operate in the restoration.

Every nation, it seems, enjoys, in its youth, a period of wild exploitation and wastefulness. But when the wild oats are sown or should all be sown, then a decision is reached and the nation takes one of two roads. One road leads to constantly lessening production and ultimate abandonment; the other to a continued use of conserved natural resources.

North Africa, once the granary of the great Roman Empire, took the wrong road and eventually became a desert. The Eastern Mediterranean countries took the wrong road and many of the once glamourous cities in that region have been completely and permanently buried by the product of erosion. China continued on the wrong road for so long that millions of Chinese now die annually as a result of famine or floods.

Central Europe saw the handwriting on the wall and interpreted it correctly. France and Germany, both old and thickly settled nations, have a larger percentage of wooded area than does Old Ontario. Britain has more than twice as much. Scandinavia, still densely wooded, has the best forest conservation policy in the world.

In Nora Wahn's book, "Reaching for the Stars" there is a chapter telling how the German people were zealously cutting down their forest in order to grow more food; but they found eventually that as they destroyed more forest and brought more acres under the plough food production decreased. They diagnosed the situation correctly and there developed in Germany, as in France, a state policy of retaining 18 to 20 per cent. of the land under forest cover.

It is only in the last twenty years that the United States has ceased to sow its wild oats and there is now in force across the line a huge conservation programme involving the expenditure of millions of dollars. Canada awakened only in the last five years and while exploita-

tion and waste have not been checked there is a rapidly developing public opinion that will demand state leadership, appropriate government policy and a programme of conservation.

We have sown our wild oats in the characteristic care-free manner and there are signs that Canadians are ready to settle down to a policy of restoration and conservation.

Before suggesting that urban and rural people join hands in the new programme of community development it might be well to establish the fact that rural-urban co-operation is already functioning in regard to suburban roads, secondary education, law enforcement and care of the needy.

These are on a contract basis, both parties entering into an agreement to bear their rightful share of the costs and to contribute those services for which they are best equipped.

I have mentioned the contractual relations between town and country but more significant, in my mind, is the purely voluntary co-operation sponsored by Chambers of Commerce, Boards of Trade, Service Clubs and lodges. These groups of urban citizens have gone out into the country, they have organized and aided youth clubs of all kinds and during the last 25 years they have done a wonderful job and have created a splendid bonne entente between rural and urban people.

The foundation for this new movement of co-operation in River Valley Development and in the restoration of the countryside is already well and truly laid.

Some urban people may ask "why should we concern ourselves with rural problems. We have enough of our own? Let the country people do their job and we'll do ours!"

That philosophy is basically sound, but peculiar as it may seem to the majority of urban citizens, the unwise use of land and the denudation of the countryside is an urban problem of major importance. With the economic and social consequences of denudation and excessive drainage I shall not attempt to deal. Those phases of the problem are repeatedly discussed in newspapers and magazines. The importance of ample water supplies is likewise emphasized but this one factor alone is so vital that urban people could very well take the lead in re-creating those conditions that will insure enough water for domestic and industrial uses and enough water to carry away the effluent from urban sewage disposal plants.

When streams and rivers become open sewers in the summer and devastating torrents in the spring, urban dwellers cannot longer ignore the dangers nor can they depend upon groups of citizens living 25 or 50 miles away, to expend labour and capital in making conditions safe and pleasant for other groups living farther down the river valley, most of whom they do not know, have never seen and never expect to

Courtesy "Farmer's Advocate"

School children of North Dumfries help to plant trees in the Waterloo County Forest.

see. I cannot refrain from saying a further word about urban water supplies secured from underground sources. Some engineers, apparently, work on the theory that the Great Architect of the Universe hid supplies of water beneath the earth's surface and it is their job as engineers to locate the hidden treasure. It has developed into a game of hide-and-go-seek with the Creator with little recognition given to the fact that underground water resources (when not replenished from large inland bodies of water) are influenced to a large extent by the character and treatment of the countryside above. This is an accepted doctrine in Northeastern United States where scores of urban municipalities have protected their watersheds with forest cover. I have visited some of these in company with E. J. Zavitz and F. S. Newman, and while the engineers and superintendents admit dozens of mistakes, some of which are readily apparent, all the officials were one hundred per cent. unanimous in the conviction that their water supplies were increased and the quality improved by suitable forest cover on their watersheds.

One of the tidiest properties of this kind I have ever seen was at Gloversville in New York State. Before going up onto the watershed we were thoroughly briefed and told what we might and might not do. The Superintendent obviously thought of that watershed in terms of health, just as a tidy housewife does of her breakfast table.

This fact has some significance: In the neighbouring Republic there are 1500 community forests scattered throughout 30 states. Altogether they cover 3,000,000 acres of land. These are not all planted by urban municipalities for the protection of water supplies but all represent community action and the type of urban-rural co-operation that I am recommending to this Conference today.

This is what I suggest:

(1) Community forests planted and developed by urban municipalities for the protection of their watersheds, to create recreational opportunities, to provide employment for their citizens and to furnish fuel and timber on a short-haul basis.

(2) Community forests developed by urban municipalities as training and recreational centres for Boy Scouts, Rangers and other youth organizations.

(3) A rapid development of the planting programme upon which counties and townships have already embarked. In this connection I recommend that state and rural municipalities locate their plantations strategically so the benefits of forest cover will accrue to all citizens, urban as well as rural.

(4) That all colleges and universities in Ontario maintain a forest of 500 or 1000 acres as standard equipment. If properly used it would soon become the most important laboratory in any university plant.

(5) That the Province proclaim a "Conservation Day" or "Community Forest Day" at some appropriate date in the spring when urban and rural people would unite in forest planting, stream improvement, roadside planting and in the improvement of ugly and waste places.

In case some people, even in this Conference, might dispatch these recommendations as "fuzzy idealism" I propose to mention a few instances of effective urban-rural co-operation that have already developed spontaneously.

(1) The Boy Scouts of this Province have planted 1¼ million trees in Simcoe County and about 200,000 in Norfolk County. From an 82 acre plantation in Simcoe County a revenue of $2,250,00 was secured last fall through the sale of Christmas trees.

(2) Senior pupils from the rural schools in North Dumfries planted a considerable block in the Waterloo County forest last spring and demonstrated what could be accomplished by senior public school pupils and secondary school pupils if they were permitted to enjoy this privilege annually. The school forests of Simcoe County, instituted by George Barr, are another demonstration of the possibilities. There is yet no record of school pupils being injured or exploited in this enterprise. I can see no reason why it would be harmful to urban pupils, and I know they would be delighted to spend half-days at just such a job in the country. It would do them good and they would learn more than when imprisoned in city school rooms.

(3) The Fish and Game Association of Woodstock and Ingersoll, with the assistance of the Boy Scouts, planted 15 acres in the Oxford County Forest during one afternoon last spring and 5 more acres during an evening's work. Wilfred Ratz, President of the Association, expressed the opinion that

when properly organized and with the assistance of the Boy Scouts they could plant 100 acres in four afternoons. The Fish and Game men aren't fooling. They want fish in the streams.

(4) Furthermore, it is not fantastic to suggest urban forest plantations, even in Ontario. The following urban municipalities have already established small plantations in neighbouring townships:
Midland, Mountain, Richmond Hill, St. Marys, St. Thomas, Trenton, Unionville, Warkworth, Woodstock, Woodbridge, Markham, Tottenham, Port McNichol, Penetang, Beeton, Brighton, Bobcaygeon, Brampton, Coldwater, Colborne, Erin, Grand Valley, Hanover, Owen Sound, Hillsdale and Orangeville.

These plantations vary in size from 2 acres to 100 acres. The average for the 27 mentioned is 16 acres. Seven of them planted on their watersheds and the most notable results have been achieved by the Village of Beeton.

Rather than attempt a complete thesis on urban-rural co-operation in river valley development I have limited my discussion to only one phase of the problem where co-operation might really commence. Papers and discussion during this Conference will reveal other possibilities and other needs.

I am not unmindful of the fact that proper and adequate development of any river valley in Ontario can only be accomplished under

Boy Scouts have planted a million and a quarter trees in Simcoe County alone—Planting the first tract in Simcoe near the Village of Angus in 1939.

Department of Lands and Forests Photograph.

appropriate legislation that bestows the necessary power upon properly organized bodies and provides for an equitable distribution of the costs. In this joint effort we leave the field of voluntary co-operation and come back to contractual relations mentioned earlier in this paper. Urban and rural municipalities have learned how to co-operate in regard to suburban roads, secondary education, law enforcement and in the care of the needy.

They would simply apply the same technique, on a much larger scale, in the development of an entire river valley. This would be done for the protection of life and property and for the benefit of all the people, rural and urban alike.

That should be our objective. In the body of my paper I have attempted to suggest something for the present—some urban-rural co-operative action to take the place of anxious inertia.

5

SOIL CONSERVATION FOR HEALTH'S SAKE

Dr. William Albrecht
Soils Department, College of Agriculture, University of Missouri,
Columbia, Missouri

It may seem paradoxical that food should suddenly come to public and critical attention, when only recently we were plowing under surpluses of it. It is all the more disturbing to many when we have led ourselves to believe American agriculture one of the most efficient, and American economics of distribution by means of steel and rubber one of the most unique of our services. Our high standard of living, and the indulgences of our desires and appetites have made us connoisseurs of good food. We have been connoisseurs, particularly, of fine qualities of food products, and of the more delicate and artistic touches of foods on an international scope. Now that we are suddenly confronted with the problem of feeding from our own crops the large share of our population under arms at a reasonably high standard of food excellence, and of sharing generously with other nations according to our customs as hosts, the sudden food shortage is more than a passing disturbance. Even wheat bids fair to disappear as a surplus bogey. Food is now a problem of its provision and not one of plowing it under.

That the soil and its *internal supplies of essential plant nutrients* should be involved in this sudden appearance of the problem of a food shortage may seem far-fetched. This internal situation of the soil has not been a change as an explosive disaster. It has been coming on gradually. Absorbed in reshuffling economic and social situations involving peoples and votes, the fertility of the soil as the foundation of agricultural production was being exported or lost to the rivers and the sea, without our notice or appreciation of it. Other nations have been brought much earlier to lower standards of living through shortages of fertility and food, because their soils have been depleted. Such nations have pushed larger shares of their peoples nearer to the sea, and now live more by means of seafood into which their soil fertility has gone. The increasing depletion of the soil makes the nations eaters of seafood, not by choice but under compulsion. We ourselves are now concerned about two seas—possibly not wholly in terms of food from them but of food for men on them and across them.

Hidden away as many of us may heedlessly believe ourselves to be in the midst of our extensive continent, we have been content with its liberal stores of fertility; not so much of it in the soils of the East,

but more in the deposits of glacial drifts as ground and well-mixed rock materials to provide plant nutrients generously in the central states; and then still more in the chernozems or the fertile black prairie soils along the shelter belt where bisons once roamed but where now wheat and Hereford cattle thrive. We have had little occasion to believe that the soil and its capacity to provide mineral-rich "grow" foods rather than only the woody "go" foods are of profound significance in the present world war. We are coming, in an international way, to appreciate the truth of the Russian proverb which says "An empty stomach knows no laws."

The soil is the ultimate foundation of all life. It supplies the basic dozen (possibly more) chemical elements that are the nutrients coming from there as ash. The soil contributes these to serve in our vegetation as the means of fabricating the carbon and nitrogen of the air and the

Table 1. Chemical Analysis of the Human Body in Comparison with That of Plants and of Soils

Origin or Source	Essential Elements	Human Body %	Vegetation % Dry Matter	Soil % Dry Matter
Air and Water	Oxygen	66.0	42.9	47.3
	Carbon	17.5	44.3	.19
	Hydrogen	10.2*	6.1*	.22*
	Nitrogen	2.4*	1.62*	—
		96.1%	94.92%	
Soil	Calcium	1.6*	.62*	0.3 3.47*
	Phosphorus	.9*	.56*	0.0075 .12*
	Potassium	.4T	1.68T	0.03 2.46T
	Sodium	.3	.43	—
	Chlorine	.3	.22	.06
	Sulphur	.2	.37	.12
	Magnesium	.05	.38	2.24
	Iron	.004	.04	4.50
	Iodine	Trace	Trace	
	Fluorene		0–3.00	27.74
	Silicon		Trace	.08
Body Compounds	Water	65	—	
	Protein	15	10	
	Carbohydrates	—	82	
	Fats	14	3	
	Salts	5	5	
	Other	1		

*These are involved in the plant and animal struggles to find enough to meet the high concentrations needed.

Amounts common as the more available forms in the soil in contrast to the total, most of which is but slowly available.

This represents struggles by the animals to eliminate it.

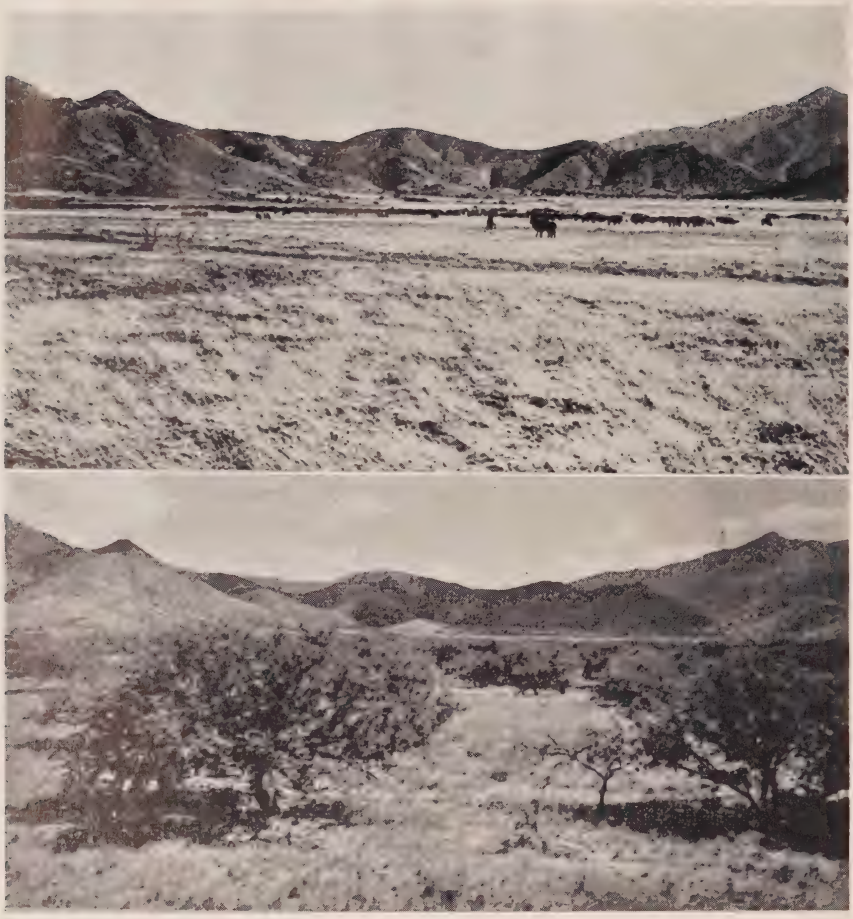
hydrogen and oxygen of rainwater into what we call plant growth. Using this vegetation as food, the animals and man fabricate these soil-given and air-borne nutrients into their particular body compounds of still greater complexities serving for the growth and energy of our own lives. The dozen chemical elements coming strictly from the soil are the construction units, the building stones of plants, animals, and man. Though, as minerals or ash they constitute only 5 per cent of the weight while the air-borne carbon, hydrogen, oxygen, and nitrogen, constitute 95 per cent of plant and animal bulk, nevertheless, the soil-given nutrients wield the hand of control in spite of our tendency to visualize the air-contributed elements as more important because of the larger mass they represent.

Accordingly as the contribution of these dozen nutrient elements is made liberally or stintingly, so it is that the soil and our treatment of it determine whether our foods are truly "grow" foods of service in healthful body construction, or whether they are only "go" goods with the more disappointing fuel values. It is the above-ground activity by plants that represents bulk and fuel values of our foods. It is the soil-fertility-providing activities of the internal chemical reactions of the soil coupled with the energy collection through sunshine above-ground that make our foods truly "grow" foods for healthy body building. We must build ourselves "from the ground up" in the fullest sense of the word.

When the responsibility of contributing these dozen elements depends on the soil, and when these contributions represent only the very minutest amounts, we begin to realize that variabilities in the supplies and deficits of the different elements may occur in the soil. It is because of these variabilities and omissions in the soil's offerings of fertility that different kinds of crops occur on different soils. Plants, whether natural, domesticated or otherwise, are different in kind and quality as we go from place to place. We have been prone to believe that the weather, namely rainfall and temperature, determine whether a certain plant grows in one place or another. We have scarcely believed that the plants, like ourselves, are much more responsive to what foods they get, than to how warm or how wet they are.

Plants are widely different in their chemical composition. These differences occur according to the differences in what the soil offers in nutrients from which the plant can construct itself. Plant species, then, reflect the fertility of the soil in their larger values either as "grow" foods under liberal fertility supplies, or mainly as "go" goods of limited nutritional values under limited fertility given by the soil.

It is true that climate is the force that makes the soil by acting upon the rock. But this does not mean that the same climate always



Courtesy U.S. Forest Service.

When nature dropped back the annual crop growth it kept humus decaying to feed the crop and organic matter going back to the soil to produce protein-rich, mineral-rich feed (above 1903). But when man came in to pasture the crop and prohibit the maintenance of the humus in the soil, the mineral nutrients in the cycle of crop growth and death were too small for any crop but woody mesquite (below 1943).

makes a soil with the same fertility content. Differences in the original rocks worked upon by climate also help to make different soils. Prairie soils are made under lesser rainfall. They are soils that are less leached of their lime, or calcium, and of the whole list of plant nutrients among which calcium is the most prominent. Forest soils are produced under higher rainfall and warmer climate that deplete the soils of much that is still left in what we call the prairie soils.

We have mistaken cause and effect in relating the soils to the crops. The prairie grasses do not make the particular prairie soils, nor do forest trees make forest soils. Rather, it is the particular fertility level within the soils that determines whether mineral-rich proteinaceous prairie

grasses will grow to support the bisons formerly and the Herefords lately, or whether only the forest trees with their few turkeys the Pilgrim Fathers found in New England and the carbonaceous or cellulosic sugar-cane and cotton crops of the South of today. Differences in the soil mean differences in the kind of crop and in the chemical composition as these crops fit into the fertility which the soil provides.

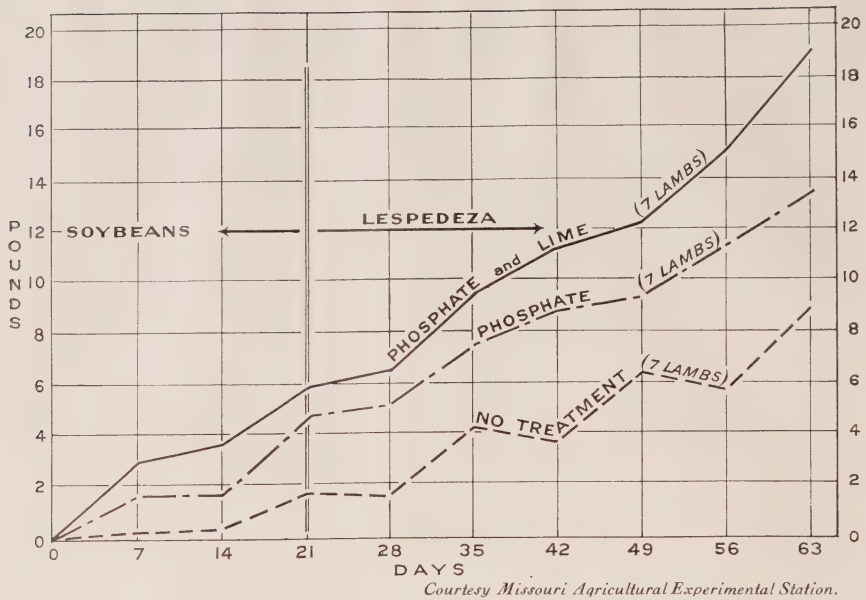
As the fertility in any soil is ample or deficient so any single crop on it is different in its chemical composition, regardless of the plant's pedigree. We have been prone to believe that the pedigree determines what the crop can do even to the fertility in the clay, or in the rock fragments, of the soil. Under this belief we have been paying our attention mainly to the crops. We have moved them from place to place and apparently believed that they will fulfill our desires regardless of the soil fertility differences. We are now beginning to realize that the soil and its chemical offerings are in control of the crop, and that the plant and its pedigree are no greater factors in plant growth than is the nourishment the soil gives.

Under the erroneous faith that plants are plants "for all that" and that plants are food "for all that," we have indulged in an extensive crop substituting or crop juggling. When alfalfa has failed we have believed that red clover could substitute. When red clover fails we substitute sweet clover. When this fails we go to soybeans and when they fail we go to lespedeza. This has been the series down which we have come with reference to the legumes, for example, in Missouri.

We have likewise been indulging in crop juggling with reference to the grains and the grasses. The tons of produce from plants have been taken as a measure of crop value instead of the nutrient offerings revealed by our inspection of the composition of the crop and therefore its real food value, as the significant measure. Our animals, their health and rates of reproduction have reflected this disposition on our part to look to the crop and to disregard the soil. We have been unable to grow our animals to greater maturity. We have been marketing them younger. We have been changing our breed types and searching for other breed types as the exhaustion of the fertility of our soil has been going on without our heed of it.

Increasing animal "diseases" have likewise been telling us that the store of fertility in our soil is declining. New kinds of "diseases," for which the physiological bases are still unknown, are on the increase. Eye troubles, acetonomia, rickets, milk fever in cattle, and pregnancy diseases in sheep are illustrations of what has been coming into prominence as animal manifestations labelled "disease," when very probably such ought to be traced back to a deficient nutrition coming by way of declining soil fertility.

Animals will recognize soil treatment effects too small to be recorded



Courtesy Missouri Agricultural Experimental Station.

Experimental trials show better gains by animals when the lambs are grown on land given proper soil treatments. The curves represent the gains by lambs fed the same amount and kind of concentrate per head per day, and the same amount of hays but grown on adjoining plots given different soil treatments.

as weight differences, as well as improvements in the crop quality lasting long after the soil treatment may have been forgotten.

An illustration of this fine taste for improved soil fertility even in animals of supposedly depraved appetite is reported by Mr. Burk, the county extension agent of Johnson County, who cites the experience by Cliff Long. Last fall Mr. Long turned his hogs out to hog down some corn. This was on a field in the far corner of which, 80 rods distant from the gate where the hogs entered, limestone had been used on a small area some years ago. To Mr. Long's surprise, the animals went back and forth from the barn lot, the water, and the tankage supply at the gate, through about 80 rods of corn on unlimed soil to consume first the corn on the limed land.

"I don't believe it," you may say, but had you seen the hogs as Mr. Long and his neighbours saw both hogs and the field, you would no longer express doubt. You would take the testimony of these hogs about soil fertility even if the chemistry of the effects of limestone on the soil and on the corn plants may seem like only so much "hokus pokus" to you.

As a further testimony, the cows on the farm of E. M. Poirot, Golden City, Missouri, declare their ability as connoisseurs of finer fertility differences reflected in the spring barley pasture. Mr. Poirot's barley was drilled last fall with an application per acre of 100 pounds

of 32 per cent super-phosphate through a tractor drill. This operation was carried out by drilling in "lands" and left the corners of the field rounded and partly undrilled during the main operation. In order to drill out these corners, a few rounds were made from the corners diagonally out into the field. This drilled a double dosage of the phosphate fertilizer over part of the field. In one of the drill rows in the main part of the field there was a very heavy application of fertilizer when a fertilizer gate remained open. This barley row was already much larger last fall.

This spring when the barley was pastured, these areas given the heavier application of 200 pounds of phosphate per acre were taken by the cattle first, and that part of the field given only 100 pounds was left ungrazed distinctly right to the drilling line. The one drill row in the main part of the field given extra heavy treatment by the open gate on the fertilizer drill was also singled out and taken first by the cattle.

Perhaps you may ascribe such discrimination to some other item than the fertilizer, but the cow knows her feed and can distinguish between difference in barley feed quality by soil treatments as small as hundred-pound applications of phosphate, as this report clearly demonstrates. Plants are sensitive with responses not recognized by the eye.

As a further illustration of the forage differences recognized by cattle, Mr. Poirot cites a case where the cattle selected a small area within 190 acres of virgin prairie pasture where 500 pounds of limestone per acre were drilled as a demonstration in 1928. He says, "The cattle have stayed on this smaller limed area this spring rather than graze over the entire 190 acres." Here in this virgin prairie, the addition of so small an amount as 500 pounds of limestone drilled but lightly into the surface has left an effect on the virgin, native forage which even the supposedly dumb beasts still can recognize after almost 11 years. It suggests that liming some of our older pasture by an early spring drilling that doesn't tear up the sod may make differences appreciated by the cow even if we don't recognize them.

The animals confined to our farms are exercising the best of their judgment to make good use of their feed and are pointing out, whenever possible, that the feed is better as the soil fertility is higher. So far, they have pointed to lime and to phosphates as essential in making the feed better to their taste, and doubtless, to their more effective growth, milk production, and other body functions. As fast as we set conditions that will let them demonstrate that they can pass even better judgment than we can, they may point to other fertility items in which our soils are deficient for best feed production. Given a chance, our animals may teach us to appreciate our declining soil fertility.

The figures dealing with our own draftee rejections in assembling men for the national service may help us understand this problem of the soil as a factor in making for better or for poorer foods, and consequently in making for better or for poorer health according to the soils concerned. When only three men out of ten are rejected in Colorado while seven out of ten are rejected in a southern state, according to a report by Mr. Rowntree, can we not look to our soils as they are less depleted in the lower rainfall of Colorado and more highly depleted of their nutrients in the South as having causal connection with this draftee situation? Is it not possible that we may be talking about "disease" and calling it a case needing "cure" when we ought to be talking about "malnutrition" and "starvation" as cases for their "prevention" through soil treatments?

We as higher animals, along with those lower in the scale, are finding ourselves pushed into this picture of soil fertility. Unfortunately, the picture is unfolding itself more in terms of *deficient* than of *efficient* living and health. Higher standards of living encourage more freedom in the choice of our foods. Choice of more sugars seems to be a freedom that is highly exercised, when in the United States we are correctly characterized as the "sugar eaters," since over a hundred pounds of sugar were consumed per person per annum in pre-rationing times. We have shoved up our "energy" foods or our "go" foods to an unbalanced proportion. To make matters more unbalanced, our soil fertility has been slipping away to reduce the "growth" values and the mineral values in many foods commonly credited with these services in nutrition. This shift in our thinking about ourselves has brought a similarly changed attitude toward our animals. They are compelled now to do more on roughage. Through crop juggling and declining soil fertility our roughage feeds have come to have fuel value mainly and too little of growth value. They too are mainly carbon consumers, when grown on deficient fertility of the soil.

We have moved in this direction, namely going toward the fuel values and away from the growth values, because we have been thinking about farming the weather and the climate in place of thinking about farming the soil. We have been giving emphasis to moisture as the main criterion of crop production. Too little is understood of the fundamentals in plant nutrition. The plant nutrients from the soil are not swept into the plant roots by the flow of water into them, as was once believed. Rather, the chemical pressures related to the concentrations of the nutrients on the clay portion of the soil determine the fertility movement into the crop roots. We have been prone to believe that large amounts of water mean large yields, and that large yields of plant bulk are an index of excellent production. We are now beginning to realize that it is not the water that determines the efficiency of the

This animal "went down" with a break between the pelvis and the spinal column to paralyse the hind legs, because it was given feeds from one of the soils of low fertility where farmers say they have "no luck" with livestock. The shinbone on the left, of this animal, is shown in comparison with that from even a younger animal grown on feeds from treated soils.

fertility of the soil, but rather the converse is true, namely, the soil fertility makes the water more efficient. It is the fertility difference that comes in as a cause when a 40-bushel crop of wheat can be grown in western Kansas with 25 inches of rainfall, and yet 40 inches of rain will not even guarantee a 25-bushel crop of wheat in Missouri. The nutrients offered from within the soil more than only the water coming from above the soil are at the basis of our crop production, our animal production and our human health.

The soil is made by climate. The crop yields are determined by the soil and its fertility in relation to the climate. Should we start with the rock itself, we can picture the view that the rock is changed into soil through processes of soil construction. These are constructive processes that make for more fertility and productivity in going eastward in the United States, for example, from the desert as the annual rainfall increases to about 30 inches. In the pattern of the climate of the United States, the 97th meridian represents approximately the line of 30 inches of rainfall. As the rainfall goes above 30 inches, and as the temperature

rises, the climatic forces bring on processes of soil destruction. East of the 97th meridian the higher rainfalls and temperatures represent soil destruction. West of this line the rainfall represents soil construction. It is east of this line that we find our forest soils. It is west of this line under the influences of lower rainfall—and to some distance east of the line where there is higher evaporation as in part of the cornbelt—that we find our prairie soils.

The prairie regions amongst the forests in Alabama and Mississippi, and again in Texas seem to be misplaced, according to this reasoning. Prairie soils of the black soil belt in Alabama are there because of the high lime content of the soils even though this is in a high rainfall region. The high lime content was retained because of the high lime materials originally serving as parent material of the soil. These lime-rich soils of Alabama and of Texas make prairie vegetation today in spite of the high rainfall and the forest vegetation surrounding it.

When we take the distribution of crops that grow naturally or readily across the United States we find particularly nutritious grasses and alfalfa as common crops in Kansas. We speak of the alfalfa crop as a "growth" food, and prescribe it for young animals and for production of milk, the natural food for growing animals. We find corn, one of the grasses, common in Iowa and Illinois, the two states on the eastern limit of our prairie soils. As we go south from these states, there is cotton, but this is on soils that were originally forests. In the tropics there is rubber, another forest crop where the rainfall is still higher and the heat more intense.

In this transition from the west to the southeast and across this array of crops, we pass through a definite series of chemical compositions of the crops at the same time. If the pattern of the chemical composition of the crops should be superimposed on the soil fertility pattern, the crops would reflect the soil's delivery of the nutrients according to the more recent concepts of this in relation to soil development in different climates. In this transition across the states one goes from the "grow" foods of the West on the high soil fertility to the "go" foods of the Southeast and the low fertility of the soils.

It does not follow, necessarily, that one must go far and wide to cover soil differences sufficient to bring this shift in nutritional values of the crop. Such shifts have been occurring in a single soil and in a single place in consequence of time, of intensive crop removal, and of neglect to return fertility to the soil. This shift has taken place most rapidly as the soils were initially less fertile in organic matter and in nutrient reserve minerals of the silt and sand fractions.

The rapid exhaustion of the calcium supply in our soils is familiar as you remind yourself of the prevalence of red clover not so long ago

where liming was later necessary to get this crop, and where today clover will not grow. The prevalence of the liming practice testifies that our cropping under disregard of the soil and its exhaustion is equivalent to moving our soils farther east into higher rainfall or the territory of the "go" foods, while liming is a partial attempt to hold them in, and push them westward toward the territory of the "grow" foods. Other nutrient elements, such as nitrogen and phosphorus, put into the soils are also helps by which the soil is magically pushed into regions of greater nutritive services to man and beast by way of more nutritious vegetation.

Our increasing and more intimate acquaintance with the Old World is bringing us to realize its exhausted soil condition and to appreciate our own fertility needs and supplies more thoroughly. Perhaps the present international disaster will take many of us away from home far enough to give us a more comprehensive view and a better perspective of our soils. That view, even after some extensive war period, will still carry a bigger welcome in post-war than any foreign soil view, as was true for the returning Yank soldier in 1918, who addressed the Statue of Liberty in these words, " I salute you, dear Lady, but if I ever do it again, you'll have to turn around." Perhaps in viewing critically our post-war situation, the fertility of our soil will get its proper appreciation—prompted by rationing experiences at home as well as army deprivations abroad—to reshape our sense of values of it.

Soil conservation has just begun. Its evolution to date has brought it from building dams as cures to crop cover and proper soil management as prevention for running water and soil erosion. It is moving rapidly toward consideration of the internal condition of the soil, namely its fertility that grows the cover, encourages water infiltration, overcomes droughts, fills our wells and makes the lands bloom with foods for a healthy nation.

You and I are probably going to be pushed much closer to the soil than will be done by our first "Victory Garden." We shall doubtlessly become better "Friends of the Land" in a deeper sense than one simply invoked by a backyard hobby. We shall soon realize that our soil fertility, like our scrap iron, has too long been exported. We need to begin now to cherish jealously the glaciated area of the central United States, and the "Midlands" of the United States or the belt of chernozem soils extending from Minnesota to Texas. We need to appreciate the soil more, as well as to recognize erosion. Erosion has been hauling away the very body of the soil because we first extracted the fertility to weaken the body in its production of self-cover. That weakened soil body is reflecting itself now in weakened human bodies so that a "Town without a toothache" is startling news with headlines in place of a normal expectancy. Good health is such an anomaly that

even the doctor doesn't know what his patient should be like when he finishes with him.

While we have moved to the "go" foods and speeded up our lives to burn them out in many ways, we have also burned out the fertility of our soil, that will be needed so much more in the near future. In rearranging the world's economic conditions, certainly the problem of food will not be considered as only a matter of tariffs, prices, and politics, but rather a matter of greater service in sustaining life that depends on the fertility of the soil. The map of the world can be properly remade only on the basis of its soil on which the nourishment and final contentment of peoples rest.

Certainly our national health picture as it is coming into clearer view from the data collected in assembling our armed forces will give us a clear conviction that our health is determined according to the soil. This view should likewise bring into focus the international picture as it rests on the different soils. We hope there will be some artistic mind on the final settlement committee which will correctly interpret what can be seen in terms of the fertility of the different soils. Regardless of the multiplicity of colors that may be involved, the picture should have but a single caption as a forceful reminder of what has been said in part before, namely, our national health, as well as "our national wealth, lies in our soils."

6

REFORESTATION AS A MEANS OF CONTROLLING RUN-OFF

E. J. Zavitz
Chief, Division of Reforestation,
Ontario Department of Lands and Forests, Toronto

REFORESTATION and woodland protection in Southern Ontario has been a subject of general interest for many years. In the earlier years the emphasis was on the problem of wood supplies and forest products. While the value of the forest in relation to forest products and their monetary benefits has been established, it is only of late years that the average man has been impressed with the urgent necessity of maintaining forest cover for its indirect benefits.

Perhaps the most important indirect benefit, dependent on a proper forest cover, is the maintenance of an adequate ground-water supply. This underground water supply directly affects agricultural crops, the life of wells and springs, and the life of our rivers.

To understand and appreciate the influence of forest cover on these problems, let us briefly consider the conditions existing in the forest, as compared to those on cleared and barren land. The forest floor is composed of leaf litter and humus all permeated with the roots of shrubs and trees. Rain falling on the forest floor does not run off suddenly, but it is taken up by the soil and stored for future use. Snows of winter are held under the forest cover and allowed to melt slowly, the water gradually reaching lower levels of the soil. It has been found that frost does not go down as deep in the forest as upon the open fields. The fact that forest cover prevents the rapid run-off of rains and melting snow, makes it vitally important that a good percentage of the watersheds of our rivers be kept under forest cover.

As foresters we do not claim that forests will prevent floods in periods of exceptional meteorological conditions, but we do believe that forested watersheds will lessen their damage. Time will not allow me to cite records from European and American sources as to forest influence on water conditions, but I assure you that the consensus of opinion is that forest cover tends to equalize the flow throughout the year, by making the low stages higher, and the high stages lower.

Let us now consider reforestation as a means of controlling run-off. This subject should be considered as woodland protection and reforestation. The clearing of land for agriculture, and the removal of timber for forest products, has left Southern Ontario with less than 10% of woodland, many townships having less than 5% of woodland.

These figures, taken from municipal statistics, do not give the true picture of conditions, as many so-called wood-lots do not fulfill the requirements of a normal forest. These neglected wood-lots are composed of scattered, inferior, or defective trees. The ground cover is impervious soil, with grass and weeds, giving very little protection to the absorption of rainfall and snow. Grazing in many cases has brought about this condition.

You will observe, in looking at the watershed map of Southern Ontario, that there are certain outstanding areas in which a number of our important rivers have their source. Look at the area in which the headwaters of the Grand, Saugeen, Nottawasaga, Humber and Credit originate. Much of this area is hilly, rough, and of small value for agricultural crops. Then travel across the Iroquois Beach ridges, from the source of the Don to that of the Ganaraska. I am afraid that most of us only see these parts of Old Ontario from a motor car, on a paved highway. I can assure you that in these areas there are many thousands of acres which never should have been cleared, but which should have been kept under forest, for forest crops and watershed protection. In the relatively small area of the Ganaraska Watershed, about 66,000 acres, a little more than one-half has been classed as agricultural crop land.

In this paper we are chiefly interested in the question of reforesting denuded lands, and improving and protecting the existing woodland on the upper watersheds of our rivers.

In so far as reforestation is concerned, we have experience and demonstrations enough to carry out any programme. We have private and municipal forests of various ages and kinds of trees. It has been demonstrated that forest can be put back on the most barren lands. What is required today is an organized effort to rehabilitate these areas. This means trained men, and money, with legal authority over the area in question, to prevent private interests from again creating barrens and destroying the natural forest protection of vital watersheds. Considerable public sentiment has been aroused against the wholesale destruction of private woodlands. Legislation, and machinery to administer the enforcement of forest protection on our important watersheds, should at least be given first consideration.

We mentioned as an important part of any reforestation programme the problem of money. It may be of interest to survey the financial aspect of this problem. We have forests at present, planted during the last thirty years, on poor, sandy soils, that are producing over one cord of wood per acre, per year. This is an annual rental of at least $3.00 per acre. For many years, state and community forests in Europe have been paying annual net revenues of from $3.00 to $12.00 per acre.

Department of Lands and Forests Photograph.

One function of the provincial forest stations is the production of forest nursery stock.— Millions of spruce seedlings at the St. Williams Station.

We started this paper recommending reforestation for its indirect benefits, but got to the sordid financial standpoint in the end. However, if we can develop sources of labour, and look forward to financial returns, as well as obtaining protection for our river valleys, we should not object.

It may be of interest to briefly outline the status of reforestation in Ontario at the present time.

Three provincial forest stations have been established for the production of forest nursery stock, and demonstration forest plantations. These stations are located in Norfolk, Simcoe, and Durham counties, The nurseries at these forest stations have an annual output of around twelve million trees, which are distributed to private owners, municipal projects, and to demonstration planting projects on Crown lands. Annual planting by private owners amounts to about seven million trees, and five million to municipal and provincial projects.

Several hundred demonstration plots have been made by townships. These plots, from five to fifty acres, are usually on waste land areas along highways, and serve as examples. Some of these plots are located on sand areas which had become a menace by sand drifting over the highways.

One of the most interesting phases of the reforestation movement is the County Forest. Previous to 1922, legislation had been secured to enable counties to acquire land for reforestation purposes, and to enter into agreements with the province for the development of such lands.

At present fifteen counties have undertaken this work. Over twenty-eight thousand acres have been reforested. Much of the land, acquired by the counties, was idle sand lands. Some of the earlier plantations are today thirty to forty feet in height, and demonstrate that these non-agricultural soils can be made productive. There are still thousands of acres of similar land waiting for improvement.

The policy of placing idle and waste lands under forest management has many arguments in its favour. It will pay as a financial investment; assist in ensuring a wood supply; provide labour in rural districts; protect the watersheds and conserve water; provide breeding ground for birds and wild life; and make this a better country in which to live.

DISCUSSION

MR. W. RAYWOOD SMITH: I would like to ask Mr. Zavitz if there is any special way to handle black muck swamps for the growing of trees and also the preservation of water. A lot of them are dried out, yet apparently not put to any land use. They are just growing willow and poplar. I thought Mr. Zavitz might give us an idea or two on how the swamps might be brought into some kind of production, either for water or timber or something.

MR. ZAVITZ: The black muck swamps are usually a pretty difficult problem from the standpoint of weed growth as well as willow which compete with any tree planting scheme, but there are a number of them in which no doubt, willow and soft maple and probably in many cases, elm could be introduced. I imagine it would be more expensive than planting on many types of sand land such as we have today, but it is a relative question, and I think should only be judged on the ground of the actual conditions.

Department of Lands and Forests Photograph.

Planted forests not only prevent rapid run-off but also provide valuable returns in wood products for the future.—A thirty year old plantation of Red Pine (pinus resinosa) on light land in Southern Ontario.

7

"EROSION CONTROL AND SOIL CONSERVATION"

Professor G. N. Ruhnke
Director of Soil Surveys, Ontario Agricultural College, Guelph

AN important phase of river valley development is that which concerns the soil and the land. The problems of erosion control and soil conservation are of particular significance where farm lands form the major proportion of the land resources of the watershed. Forested land is protected land and is little subject to erosion. Cropland, pasture land, or idle land, may suffer serious loss of topsoil when suitable controls are not practised. It is desirable, therefore, to emphasize the importance of erosion control as a fundamental part of the soil conservation programme.

Soil erosion is the result of the scouring action of wind or water on the exposed land surface.

Wind erosion in this region is most common in areas of well, to excessively drained sandy soils. The "blowing" or drifting" of such soils has resulted primarily from indiscriminate deforestation, subsequent rapid depletion of the soil humus by cultivation and cropping, or the destruction of the natural grass cover by excessive grazing.

Erosion by water takes place on sloping land wherever the flow over the surface is fast enough to move soil particles. The rate of erosion depends on the character of the soil, the vegetative cover, the climate, and the steepness of the slope. According to the laws of physics, when the speed of run-off water is doubled, its cutting power is multiplied by 4, its power to carry soil by 32, and the size of particles by 64. All practices that speed the downhill flow of water naturally hasten the process of soil washing. Up and downhill plowing and cultivation, continuous cropping and overgrazing of steep slopes, almost inevitably lead to eroded soil, lowered productivity, and untillable land.

Two main types of water erosion which affect our lands are, sheet erosion or sheet wash, in which a thin layer of soil is removed from a large area; and gully erosion, in which the concentrated flow of water cuts deep troughs or channels in the soil. Gully erosion, being the more spectacular, is easily recognized. But sheet erosion, which takes place gradually, may go on quite unnoticed until failing crops, exposed subsoil, and numerous small gullies call attention to the damage done.

There are plenty of examples of all three types of soil erosion scattered over our countryside, and as might be expected, many of these occur within our so-called better farming areas.

It is only within very recent years that we have begun to realize the extent to which soil erosion has taken place here in our own Province. The information which we have obtained from our soil surveys, in twenty-four counties in Southern Ontario, is of interest in that respect. Conservative estimates based on our soil maps indicate that, in the surveyed counties, an average of fifty percent of the total area of lands is suffering from moderate to severe erosion. If those counties having a large proportion of flat to almost level lands are excluded from consideration, the proportion of eroded lands becomes considerably higher, as, for example, almost seventy percent for Waterloo and Durham Counties, seventy-five percent for Northumberland County; and seventy-seven percent for Haldimand County.

The detailed soil erosion land use survey of the Hope Township Project Area, in Durham County, gives the most accurate data on soil erosion so far available for any area in Ontario. A detailed map and report of this survey were reproduced for limited distribution, and an abridgment of the latter is included as Chapter XI of the Ganaraska Watershed Report. Soil type, slope, kind and degree of erosion and present land use were mapped on a scale of 4 inches to the mile, over an area of 22,000 acres, representative of much of the morainic area and associated lands in South Central Ontario. This survey showed that in the area studied, 12.3 percent of the land has suffered severe to very severe erosion, another 24.3 percent has suffered moderate erosion and another 27.5 percent has suffered at least slight erosion. In other words, only 36 percent or slightly over a third of the land shows little or no signs of erosion; it is significant that this land was made up mainly of flat, poorly drained, outwash sands, muck, and bottom land, with only a few gently sloping areas well covered with forest or pasture. Of the 64.1 percent of the land subject to erosion, over 12 percent has already suffered damage to such a degree that it should be removed immediately from cultivation.

If the data with respect to the degree and extent to which erosion is taking toll of our soils appears rather meagre, there is enough, however, to confirm our suspicions that erosion is a real problem and we should be doing more about it.

The importance of reducing the volume of surface water run-off for the control of sheet and gully erosion is readily apparent. But there is another equally important reason for controlling run-off, to conserve as much water as possible for storage in the soil, for use by crops, and to replenish the underground supplies to feed the springs, the streams and wells. The significance of water conservation for crop use needs particular emphasis. It has been estimated by the workers at the Purdue Agricultural Experiment Station that 20 inches of

water are required to produce 100 bushels of corn per acre, assuming that nutrient deficiencies in the soil and other limiting factors were eliminated. The average total rainfall for Ontario during the growing season from April to September inclusive, based on records from 1882 to 1942, is given as 15.70 inches. A considerable proportion of the summer rainfall comes in the form of thunderstorms and heavy dashing rains which are conducive to heavy surface run-off from cultivated fields. When losses of rainfall by run-off and from evaporation by hot, dry summer winds are taken into account, the amount of effective soil moisture for crop use is likely to be considerably less than would be inferred from the precipitation records alone. Thus, on rolling lands, even where the evidence of soil erosion may be slight, the adoption of conservation farming practices to hold the water on the land is likely to be well repaid by increased yields of crops, increased flow of springs and general improvement in the ground water supply.

The starting point in soil conservation is proper land use—using our lands for the crops they are suited to produce and in such a way that they will keep on producing them. This means using for rotation crops, land that is best adapted to growing such crops, and the adoption of necessary soil conservation practices to maintain that land. It means not using for cultivated crops unsuitable land which would be more safely and economically used for hay, pasture, or for woodland.

Strip cropping and sod waterways are needed on long smooth slopes such as this to control severe top washing.

O.A.C. Department of Extension Phot

Selective service for the land is the foundation of a sound soil conservation programme. The soil conservation measures necessary to meet the needs of different classes of land vary greatly in number and kind.

For some farms only a few simple adjustments in existing farm practices may be necessary. For example: improvement in drainage of wet lands; change in the rotation of crops to make a better balance between soil depleting and soil conserving crops; the use of cover crops to keep the land protected, and when disced in or ploughed under, to add enriching humus to the soil; the more effective use of crop residues such as cornstalks, straw, and similar materials disced in to provide a "trash" or "stubble" mulch; more effective storage and utilization of farmyard manure; the use of adequate amounts of lime and fertilizers on rotation crop land and pasture land, as the need is indicated by soil tests; harrowing, clipping, and controlled grazing of pasture lands; protecting existing woodland from livestock, and reforestation of any portion of the farm unsuited for cropland or permanent pasture. The combination of the foregoing measures may be considered as the basic requirements for simple soil conservation farming. The fact is that many of our best farmers have already adopted these practices as part of their regular farm management programme.

However, for adequate protection of sloping crop lands from excessive run-off and soil erosion, supplementary conservation practices are necessary. The three principal measures most used and adaptable to a wide range of conditions are, contour cultivation, strip cropping and terracing.

Contour cultivation is the operation of tillage machinery on the contour, and it includes the operations of plowing, planting and cultivation. (A "contour" or "contour line" is a line connecting points of equal elevation hence a contour is on the level.) Thus cultivation and cropping are carried out on the level, around the slope, and not up and down it. While this practice alone does aid in saving soil and water, it is usually combined with strip cropping for more effective results. On permanent pasture lands on moderate to steep slopes, contour furrowing to check run-off is recommended as a simple but effective practice.

Strip cropping is the growing of strips of densely growing crops (hay or grain) between strips of clean-tilled crops (corn, roots, etc.) planted along the contour. Usually a definite rotation of crops is practised on the contour strips, rather than by separate fields. Contour strip cropping is a desirable practice on all moderate and uniform slopes. Fields with variable slopes in several directions do not lend themselves to strip cropping. Locating and staking the strips and planning the rotation involves many problems and should be done only with technical guidance.

O.A.C. Department of Extension Photograp

Over-grazing of poor sandy pasture land has led to soil drifting.

Terraces of many different designs are used for a variety of purposes in soil and water conservation. In low rainfall areas they are used to catch and store water, while in the humid regions they are intended to impede the flow of surface water, retain what the soil can hold, and dispose of the surplus without damage to the land. A simple form of terrace known as "diversion terrace" or "diversion ditch" is used to break the flow of water down long uniform slopes and protect contour strips from breaking over. Terraces require careful location, and provision for a grass sod or other protected waterway, to safely carry the discharge off the land. Diversion terraces or ditches are easily constructed with a plow, but the installation is most safely made under the supervision of an experienced conservationist.

Gully control involves corrective treatment of existing gullies by installation of dams, tree planting, etc., and preventive treatment of drainage ways by sodding, or fertilizing heavily and seeding with suitable grasses. Gully formation is less likely to prove a problem

where run-off is controlled by a suitable combination of soil conserving practices.

Although the employment of the required soil conservation measures for the rolling croplands should reduce run-off to a minimum, a well located farm pond, properly designed and constructed, provides a supplementary water supply and reservoir for periods when there is water shortage due to failing wells. If banks are sodded and planted, and the area fenced, it serves also as a wild life refuge. Such ponds are usually an acre or so in extent depending on the size of the drainage area. Experienced conservation farmers say "a pond on every farm should be the objective". It should be noted that some soils are much better suited than others for pond construction, as a sufficient content of clay is necessary to provide a seal against seepage.

Having briefly reviewed the needs and the basic techniques for soil conservation farming, the next step to consider is how to get the soil conservation programme into action on our farms.

The most direct and also the most effective approach is by means of a farm planning service for the individual farm. Farm planning is a

Unprotected gullies menace valuable farm land.

O.A.C. Department of Extension Photograph.

specialist's job. It begins with the making of a survey and a detailed map of the farm on which is recorded the soil type, slope, kind and degree of erosion, present land use and other necessary data. From this survey a farm plan is prepared showing the revised land-use for various areas on the farm; the boundaries between woodland and pasture or cropland; boundaries between pasture and cropland; and boundaries between different classes of cropland. The contour lines are plotted and if strip cropping or terracing are necessary they are shown also in their proper location. The field and fence boundaries are determined and indicated. The revised rotation of crops and acreage adjustments are all computed.

The map is then taken to the field and in consultation with the farmer the final adjustments are made to suit the needs of the particular system of farming in a sound and practical way. Finally the farm conservation plan is prepared in detail giving complete information and instructions for its use. When the plan is finally adopted by the farmer, assistance is given in laying out contours and establishing the new field unit system by gradual adjustment of the existing cropping and management programme.

Farm planning involves an integration of knowledge concerning soils, agronomy, livestock feeding, economics, hydrology, woodland management, etc., and requires the services of technical advisers especially trained for this work.

The degree of success with which the conservation plan may operate depends also on the full co-operation of the farmer for whom the plan is made. He must assume the responsibility for having his soil tested; apply lime or fertilizers as required before legume seeding, etc.; establish strip cropping and field unit systems, and make necessary fence changes; renovate pasture; do selective cutting and proper woodland management; and provide adequate wild-life protection. Only in this way can soil conservation planning be made effective.

Since farmer and land-owner co-operation is so essential to the establishment of a soil conservation farming; it is desirable that action to initiate a soil conservation programme should come from the farmers themselves.

Already, under the guidance of the county agricultural representatives, county agricultural committees are organizing and asking for the necessary technical assistance. In two counties, Simcoe and Essex, the ground work has been laid for action programmes for soil conservation. The farmers in these counties recognize the need for such programmes and are asking for more assistance in getting them under way. The Ontario Agricultural College in co-operation with the Experimental Farms Service, Ottawa, is hoping to enlarge the present staff of soils specialists to more adequately meet this growing need. Two fully

experienced soil surveyors are at present in attendance at the Soil Conservation Training School at La Crosse, Wisconsin. These men, on their return, will form the nucleus of a technical staff for farm planning service.

From the standpoint of a supporting programme of research and investigation, there is need for completing as rapidly as possible, soil surveys in those areas not yet mapped. Soils classification and mapping are basic needs in soil conservation work. There is need also for more field plot and laboratory investigations in connection with soil fertility maintenance problems. Investigations dealing with run-off prevention, erosion control, etc., are needed to provide data from our own conditions, and to provide a sound basis for the adaptation and most effective application of soil conserving practices.

I have dealt almost entirely with the problems of erosion control

For the adequate protection of sloping crop lands from excessive run-off and soil erosion, supplementary conservation practices are necessary. The three principle measures most used and adaptable to wide range of conditions are, contour cultivation, strip cropping and terracing.

U.S. Soil Conservation Service Photograph.

and soil conservation as they relate to farm lands, because they are the lands which present the major erosion problem in most watersheds. The existing forest lands are well protected. Other areas which can be reforested by municipalities or governments can readily be brought under control. But, in the final analysis, land use on individual farms is the dominant factor in the overall problem of run-off, erosion control and soil conservation.

DISCUSSION

MR. W. ROSS GRINELL, DEPARTMENT OF LANDS AND FORESTS TORONTO: Does Prof. Ruhnke think that sub-surface tillage controls erosion to any extent on good farm soil? This might, in some cases, take the place of the more expensive and more complex contour and strip cropping.

PROFESSOR RUHNKE: I would have to say frankly I don't know because we haven't carried out such experiments and it is just that sort of thing that is very much needed in the supporting programme of research which I mentioned.

MR. LESLIE HANCOCK, GUELPH: I would like to ask Professor Ruhnke a question with regard to the common practice of liming. Of course Professor Ruhnke knows and some of the rest of us know, our swamps and areas where there is no lime are very high in humus and this is so important to preserve the moisture. Now, it has occurred to me many times that liming has great benefit in crop increase in certain lines, and though we have, as agriculturists, promoted the practice of liming with the idea of bigger crops, at the same time I think Professor Ruhnke will agree that lime does destroy or break down the decaying vegetable matter so important from a conservation viewpoint.

I would like to ask Professor Ruhnke whether he does not think it a good idea that we do not encourage liming of the hills, that is those parts particularly subject to a certain amount of erosion, my point being if we encourage surface litter on the hills and do not lime we will tend to a condition that will prevent erosion.

PROFESSOR RUHNKE: I think we can hardly say that liming is destructive of the soil organic matter unless we are thinking in terms of quick lime or burned lime, which at one time may have been used rather extensively, and is much more active in its effect and may of course stimulate decomposition of organic matter very rapidly. The fact is, in a majority of the eroded areas of which I am speaking, the sub-soils are already very well supplied with lime. We have a very high percentage of limestone in the parent materials from which the soils have been derived and actually there is little or no need in most cases for applying lime to these eroded ridges or tops of the hills. Some of them are already too well supplied. In fact we have certain soils which have been eroded, where the pH of the soil goes up over 7.5 and even a little higher.

But from the standpoint of favouring legumes in the rotation (alfalfa, red and sweet clover, etc.), where the soil is known to be in need of lime it is a very important and a very necessary practice. I think Dr. Albrecht's talk last night brought that out in an impressive way. We haven't quite the same problem with calcium supply as in some parts of the United States, but we do have areas that require lime and it isn't always the eroded portions of the field that need it.

MR. E. V. BUCHANAN, PUBLIC UTILITIES COMMISSION, LONDON: Professor Ruhnke has pointed out to us that it will be necessary for farmers to obtain the services of experts to carry out this programme of soil conservation. Now, as a Municipal servant, I know how difficult it is to persuade City Councils to hire at their own expense experts on municipal problems. How much more difficult will it be to persuade the individual farmer to hire a consultant, and as this matter is for a common good as well as for the individual, I would like to ask the Honourable Dana Porter or Dr. Langford if it is the intention of the Government to provide consultants for this work?

DR. LANGFORD: One of the purposes of this whole meeting is to determine and clarify the Government's policy in this regard. I don't think we are prepared to make any statement or commitment at present. It is one of the things we hope will grow out of this Conference.

MR. E. J. CAMPBELL: I would like to ask Professor Ruhnke if the survey which his Department has been carrying on, has extended to the Counties of Kent and Essex, and if so, what are his suggestions to us down there in the way of maintaining our soil. We have rather flat land. It is not subject to serious erosion, but I think we are going to be faced with the problem of fertility maintenance and I would like to ask if he has any suggestion for maintaining our level of fertility.

PROFESSOR RUHNKE: Mr. Campbell has given me rather a large assignment. I should say this, in answer to the first question: the soil survey in both Essex and Kent Counties has been completed. The soil map for Kent County has been published and copies can be obtained from the County Agricultural Representative's Office at Chatham, or from the Department.

For the other part of the question, with regard to erosion, Mr. Campbell is perfectly right in saying that the erosion problem is a minor problem on the flat land in Kent and Essex. Apparently the fertility problem is the basic problem there. The physical condition of the soil in relation to internal drainage is also an important problem.

It would be impossible in the few moments we have for discussion here, to attempt to diagnose that problem and prescribe for it. I think we can say this: those areas are areas very intensively cultivated in crop. In spite of the fact that those lands were very fertile lands to begin with, the drain on soil fertility has been very heavy. A great deal of the original organic matter has been destroyed and worked out of them and the problem revolves around restoring that organic matter and replacing nitrogen and mineral nutrients, as may be required to put the soil back in a productive condition. Other questions which are not entirely decided are, how much fertilizer, how frequently to apply it in the rotation, and how best to apply it—those are fundamental problems.

MR. G. W. HOFFERD, NORMAL SCHOOL LONDON: I was wondering if Professor Ruhnke would lay down a rule about liming soil. Would he say that clay soil that is fairly well drained as a rule does not need liming, or would he say that it may quite likely need liming? That goes back to the origin, of course, of the clay. I am thinking of the kind of fundamental material from which clay is made.

PROFESSOR RUHNKE: In answering Mr. Hofferd's question, we like to depend on the actual test of the soil for acidity to be sure whether or not it may need lime. There are some of the clay soils that are already abundantly supplied. There are some very deficient.

For example, 75 to 80 per cent of the soils in the Niagara Peninsula above the escarpment which are very heavy in texture and in the majority, clay, are very deficient in lime in the surface soil, but you couldn't apply that rule to clay soils generally over the Province. The only sure indication is to make an actual soil survey.

8

"UNDERGROUND WATER SUPPLIES"

Dr. J. F. Caley
Geological Surveys Branch, Department of Mines & Resources, Ottawa

NO consideration of river valley development, or of conservation, or of re-development of agricultural areas could be adequate or in any way complete without some mention of that water which occurs beneath the surface of the earth, and particularly of that part of the sub-surface water that is within the zone of saturation, the ground water. For it is this water that is primarily responsible for the continued flow of surface streams and that supplies, to a very great extent our domestic and industrial needs.

The water of the earth may be divided into three:

(1) Water in the atmosphere.
(2) Water on the surface of the earth.
(3) Water below the surface of the earth.

The water below the surface may in turn be divided into three:

(a) That above the zone of saturation.
(b) That in the zone of saturation.
(c) That in the interior of the earth.

The water in the atmosphere is perhaps primarily the concern of the meteorologist; that on the surface, of the hydraulic engineer; but that below the surface is directly the concern of the geologist, the agriculturalist, and the engineer.

There is, in general, an upper limit within the earth's crust below which the permeable rocks are saturated; this upper limit is called the water table and it forms the surface of the zone of saturation. The water within this zone is the ground water. (Figure 1).

Practically all the water recovered from the zone of saturation, that is, ground water, is derived from the atmosphere. Most of it reaches the earth in the form of precipitation either as rain or snow. Of the precipitation falling on the ground, part is immediately carried away by streams as surface run-off, part evaporates either directly from the surface and from the upper mantle of soil, or by transpiration of plants, and the remainder sinks into the ground ultimately to be added to the ground water supplies. (Figure 1.)

The proportion of the total precipitation that sinks into the ground will depend largely upon the type of soil or surface rock and the topography of the area upon which the moisture falls; if the surface deposits are of sand or gravel more water will sink in than if those deposits were

of clay; if the region is hilly and dissected by numerous valleys more water will immediately drain away than if the surface is fairly flat and but little dissected. Steady precipitation over considerable periods will furnish more water to the ground water supply than will torrential rains; in this case the run-off may be nearly equal to the total precipitation. Moisture falling after the ground surface is frozen will not usually find its way below the surface and therefore will not materially replenish the ground water supply. Light rains falling during the growing season may be wholly absorbed by plants. The quantity of moisture lost by direct evaporation depends largely upon temperature, wind and humidity.

It is evident then, that the percentage of the total precipitation disposed of by run-off, evaporation, or percolation below the surface, is difficult to determine and depends to some extent upon local factors.

That part of the precipitation that sinks into the ground finds its way downward until it reaches the ground water level or until it comes into contact with a layer of rock which is impervious to its passage; such a layer may hold the water some distance above the general ground water level. This is known as perched water. If the ground water level is at or near the surface there will be a lake or swamp; if it is cut by a valley, there will be a stream.

The conditions under which ground water occurs and the factors determining its quantity, quality, and possible recovery are many. This water is directly associated with the rock into which it percolates and as this rock may (and in southwestern Ontario does) vary in its physical properties from place to place, so will the conditions affecting the ground water change.

Because of the large quantities of water that are daily consumed from underground sources, it may be thought that precipitation cannot furnish the entire supply. However, when it is remembered that a layer of water one inch deep over an area of one square mile amounts to about 14,520,000 imperial gallons and that, in southwestern Ontario the annual precipitation is perhaps in the order of 30 inches, it will be seen that over 420,000,000 gallons fall on each square mile each year. If we estimate that only 10 to 20 percent; (surely a conservative estimate) of the annual precipitation reaches the zone of saturation there is still an appreciable quantity of water available to recharge the ground water supplies.

It is not implied that the ground water supplies are inexhaustible. So long as the annual recharge, that is, the quantity of water reaching the zone of saturation is equal to or greater than the quantity withdrawn, the ground water supplies will not materially decline. Unfortunately, however, there are parts of southwestern Ontario where this condition does not prevail. It is common knowledge that once

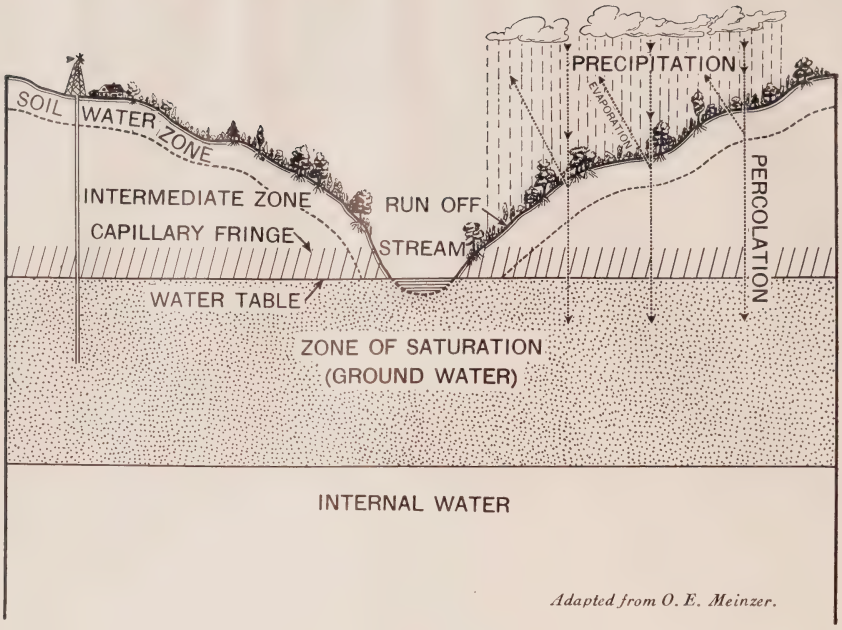


Figure 1

Diagram showing position of zone of saturation.

permanent streams are now dry, that many springs have disappeared and many wells have failed. Such a condition is in large measure the result of cutting down of forest trees, draining of swamps, and bringing into cultivation areas that perhaps should have been left as wood lots. In general, the same quantity of moisture is falling now as before the streams ceased flowing, but, so far as ground water is concerned one of the most important results of the aforementioned conditions is the great increase in surface run-off, culminating all too often in disastrous floods and reducing greatly the quantity of water that formerly went to recharge the sub-surface supplies. Couple with this the increase in population with its ever increasing demand upon ground water for both domestic and industrial needs, and it is not difficult to see that the ground water resources will still further decline unless some remedial measures are taken.

Getting back to the geology of ground water; all sedimentary rocks are to some degree porous, that is, they possess pores between the individual grains of which they are composed. Water stored within the rocks mainly occurs as filling these spaces. A very fine-grained rock containing water may have such small pores that the attraction between the rock and water is great enough to hold the water in the rock; such a rock will not yield its water to wells. Those rocks that yield their water readily are called aquifers; those that do not are impervious beds.

For the present purpose the geology of southwestern Ontario may be divided into two parts; the bedrock and the overlying unconsolidated glacial deposits. (Figure 2).

The bedrock consists of layers of limestone, shale, and sandstone that when viewed at an isolated outcrop generally appear to be flat lying but that, regionally, are known to dip from 10 to perhaps 40 or 50 feet a mile in a general southwesterly direction. These rocks are sedimentary in origin, having been formed from sediments deposited in bodies of sea water later to be consolidated into hard rock.

The water bearing properties of the various types of rock constituting this sedimentary succession vary greatly. In general, the shales, being fine-grained, are the poorest aquifers while the sandstones and limestones are considerably better.

No special study of the water in these rocks has been made, but they have been mapped over much of southwestern Ontario so that the distribution, thickness, and general physical characters of the several formations are fairly well known. In the area bordering Lake Erie, the bedrock has been penetrated to various depths by wells drilled for oil and gas and a study of these drilling records has yielded some general data regarding water. Thus it is that we know of occurrences of fresh water generally in the upper part of the bedrock; of sulphur water somewhat lower; and of salt water at still lower depths.

Overlying the bedrock is the glacial drift. During the final stages of geological history great accumulations of ice formed at several centers in Northern Canada. Due to the pressure exerted by the immense thickness of ice, the ice moved out in all directions from these centres, covering large areas with a continental ice sheet. As the ice advanced it picked up great quantities of loose rock which it carried along and which was deposited when the ice finally retreated by melting. This material is unconsolidated and called glacial drift. Several advances and retreats of the ice sheet took place and each retreat left its accumulation of drift on the surface over which it passed.

Thus, over most of southwestern Ontario the bedrock is covered with drift ranging in thickness from zero in parts of the Bruce Peninsula to over 600 feet in the region north of Toronto.

Generally, the drift consists of boulders and pebbles of various composition and size embedded in a matrix of clay to form a more or less impervious mass called boulder clay. Intermingled with this and commonly in a most complex manner, and also lying above, below, and between successive till sheets are beds, lenses and pockets of water laid sand and gravel which form the chief water-bearing members of the drift.

Throughout the greater part of southwestern Ontario most of the ground water supplies are directly associated with the glacial drift;

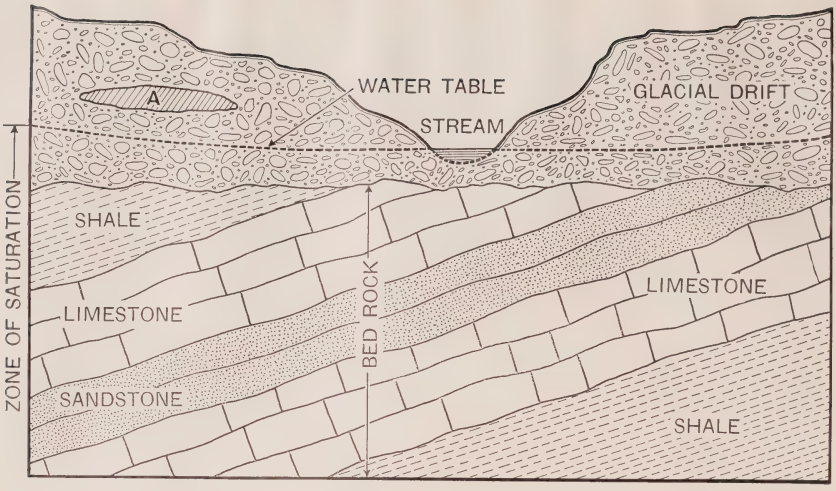


Figure 2

Diagram showing bed rock and glacial drift. A: lense of impervious clay causing perched water.

particularly is this true of our domestic supplies. Over wide areas the water table apparently stands within the drift as indicated by the fact that so many farm wells do not penetrate the bedrock beneath.

Unfortunately, except for a relatively small area in the general vicinity of Toronto, the glacial deposits of southwestern Ontario have not been mapped in detail. Much study has been given to the glacial history of the region and recently the moraines, drumlins, and other features connected with the retreat of the last ice sheet have been given special attention by Messrs. Chapman and Putnam who realized that as a basis for the study of soils, a knowledge of the surface deposits is essential.

During the field seasons of 1936 and 1937, the Geological Survey carried on ground water studies in a small area north of Toronto. Much data were collected and sufficient work was done to indicate that a detailed study and mapping of the glacial geology is essential to a real understanding of the ground water resources.

During the course of this work, some facts about the occurrence of ground water were learned. The water table in glacial deposits such as occur in southwestern Ontario may be very irregular and there is apt to be much perched water. One of the best and most widespread fresh water horizons is at the contact of the glacial drift and the underlying bedrock; and especially is this the case where the uppermost bedrock is a shale and therefore relatively impervious. (Figure 2). Although small quantities of water may be recovered from the shale formations where these immediately underlie the drift, except where it occurs near the top of the formation, it is likely to be salty water.

To conclude, to date practically no serious study has been made of the ground water resources of southwestern Ontario. With the exception of the aforementioned work done in the region north of Toronto in 1936 and 1937, most of the little we know about ground water in southwestern Ontario has come as a sort of by-product of other studies.

There is virtually no quantitative data on the subject.

To repeat what was said at the outset, it is the ground water that is primarily responsible for the continued flow of surface streams and that supplies much of our domestic and industrial needs. Surely its great importance needs no further emphasis.

DISCUSSION

MR. YOUNG: Mr. Chairman, I would like to know, what does the word "drumlin" mean?

DR. CALEY: That comes under the category of definitions. Definitions vary sometimes in direct ratio to the person who makes them. A drumlin is a little hill. It is an elongate or oval hill formed chiefly of boulder clay and having its long axis parallel to the direction of movement of the ice. The mode of formation of drumlins is I think still somewhat controversial. Some will say it has its initiation in there being a hump in the hard underlying bedrock over which the glacier carrying its load of material passes. That forms a sort of nucleus over which to build the resulting hill.[1]

PROFESSOR R. F. LEGGET, UNIVERSITY OF TORONTO: With your permission, Sir, I would like to ask Dr. Caley a question which I know he can't answer. It is a question which must be answered; I hope this Conference will go some way to answering it corporately. Before I ask the question I would like to emphasize, if I may, the importance of the picture which Dr. Caley has painted for us, because I feel, and I know others agree with me, that it is this question of ground water which is the link that binds together the many and varied groups of individuals that have assembled in this Conference. As you will know there are present hunters, anglers, agriculturists, engineers, and doubtless many other members of the community, all met here with one purpose. The one thing in which we are all primarily interested is the conservation of water, and that means essentially the conservation of ground water. So I hope, that this picture which Dr. Caley has given us will make clear the interconnection of our varied interests.

The question I want to ask is this: Why is it that in view of the extreme importance of ground water, particularly to this part of Ontario, we know so little, in fact practically nothing at all about it?

The answer is a varied one. If I may suggest two aspects of it, I would like to do so as a basis for further discussion. First, we can all realize the ravages of soil erosion because we can see it in progress. We can all realize what the cutting of trees means because we can see them cut down. We all realize what the loss of fertility of soil means because we can see its effects. But we do not see the effect of ground water depletion because it is hidden beneath the surface of the ground, and only those observing variations of water in wells know what is going on.

The second reason, and a more detailed one, is this: The one official agency that might be expected to obtain the information on ground water has not been able to do that for various reasons. I refer to the Geological Survey of Canada, one of the oldest Geological Surveys in the world, and without any question one of the most distinguished, a survey, Mr. Chairman, which a few years ago was placed in a subsidiary position in a very large Department of the Federal Government, and relegated (in the opinion of many) to be just an adjunct of the mining industry of this country.

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[1]Chapman, L. J., and Putman, D. F.: The Moraines of Southern Ontario. Trans. Roy. Soc., Canada, Vol. 37, pp. 33-41 (1943). The Drumlins of Southern Ontario, op. cit., pp. 75-87.

Geology is important to mining, but it is equally important to those of us interested in water as well. Because of its association with mining and because the Geological Survey has perhaps not had the financial support it should have had, can be attributed to some extent at least the fact that we know practically nothing about ground water conditions in Southern Ontario.

In summary, I do hope that this Conference, perhaps this afternoon, will take some steps to see to it, in so far as it can, that the Geological Survey is encouraged in the work it can do and the work it should do, in the same way as is the Geological Survey of the United States.

There is one other thing I would like to mention. I want to show the members present a pamphlet which I think is important. There is some question about discussing such things as conservation in time of war. I have here a pamphlet which has the title, "A National Water Policy." It is a pamphlet which has come out of the land that has perhaps suffered as much as any other in this war—Great Britain. Great Britain has already adopted a national water policy, even in time of war. I hope that as a result of this Conference and with the prompting of Dr. Caley's paper, we can do something to see to it that we have at least a provincial water policy before very long.

MR. G. F. STERNE, BRANTFORD, ONTARIO: Mr. Chairman, our City Engineer has dared me to ask Dr. Caley a question. I don't like taking a dare. The question I am going to ask is, does he believe or does Science believe in divining rods?

At the outbreak of the war our plant went into the manufacture of silica jel, which requires a very considerable amount of water as a wash. Our city water was a little warm and a little hard. Consequently, we drilled a well. The man that was drilling the well recommended the hazel crotch. I didn't believe in it until the bally thing bent in my hand. Our chemist laughed at it. I want to have the Doctor's confirmation at to whether it is good or bad. But even if he says it doesn't work, he still won't satisfy me.

DR. CALEY: In answer to that question, I am forced to say that Science does not recognize the hazel crotch or the diving rod as it is sometimes called. On the other hand, I must confess to Mr. Sterne that I myself have tried it and for some reason or other I could not stop the thing from turning down.

MR. E. V. BUCHANAN, LONDON: I want to emphasize the point that has already been made on the importance of this question.

It is becoming more difficult each year to augment the water from which London obtains its supply. For some reason the water table is receding. The alternative seems to be to go to one of the Great Lakes for our water supply, the cost of which would run between 5 and 10 million dollars. You can easily see if some conservation method is undertaken which would improve the present water situation that the City of London would save nearly the amount that I have mentioned.

9

THE ORIGIN AND SIGNIFICANCE OF THE GANARASKA REPORT

E. K. Hampson
Chairman of the Guelph Conference, Hamilton

THE Guelph Conference came into being in 1941 as a result of an informal meeting at the Ontario Agricultural College of a small group of men intensely interested in the preservation of our resources and alarmed at the rapidity with which at least some of them were disappearing. They represented public service organizations among which the following may be mentioned:

The Ontario Conservation and Reforestation Association.
The Federation of Ontario Naturalists.
The Ontario Federation of Anglers and Hunters.
The Royal Canadian Institute.
The Canadian Society of Technical Agriculturists.
The Southern Ontario Section of the Canadian Society of Forest Engineers.

However, neither the name nor the history of the Guelph Conference are important, but the ideas generated at the meeting are.

To this group of men trained and experienced in several fields of the natural sciences, it seemed imperative that more agressive measures be undertaken to preserve our soils, our forests and our wild life. It was felt too that such measures should be based on a scientific knowledge of all the facts and that careful surveys precede all actual field operations. The necessity of scientific planning as a fundamental principle was agreed upon by this Committee.

A report on Conservation and Post-war Planning was prepared in 1942 by Prof. A. F. Coventry on behalf of the Guelph Conference. Numerous conferences were held with both Provincial and Dominion Government officials and it was finally agreed that a survey of the Ganaraska Watershed be undertaken as a trial case. It was a joint project as between the Dominion and Ontario Governments. It was expected that from the experience gained in undertaking this survey, other similar projects might be conducted more effectively.

Unfortunately, however, a long time has passed since the Ganaraska Survey was first inaugurated and no other project has been undertaken since. The Report on the Ganaraska Watershed now released is considered to be an admirable one and Mr. Richardson, on whom fell the greater part of the responsibility of preparing it, is

to be commended on its excellence. We are pleased to know that the Ontario Government has now set up machinery for speeding up these fact-finding surveys and the calling of such a meeting as this provides good evidence of the determination of the Government to proceed with some of the more urgent problems.

It will do no harm to observe that the completion of a survey and the publication of a report concerning it is of itself worthless. The Ganaraska Report has not yet retarded erosion in the area covered by it. This is only a first step preliminary to the application of remedial measures. Our members will be interested next in seeing in actuality the restraining dams, the forested areas, the recreation grounds, soil erosion controls, crop adaptation and the other recommendations of the Ganaraska Report. This is the second phase of conservation planning.

The third and equally necessary phase is that of providing for the perpetual maintenance of such works as may require it. Forested areas will require thinning and fire preventive measures. Reservoirs may become silted up to a point where their usefulness is destroyed. Erosion controls may require continued attention. Permanent care is of almost equal importance to planning and operative enterprises.

Conservation of our renewable resources is important enough in its own right to demand the attention of our Governments, but it is particularly important at the moment, for conservation measures offer fine opportunities for at least some returned men to do useful and healthful work while fitting themselves again for civilian occupations. Moreover, many find permanent jobs in these conservation projects.

But it would be a mistake to plan conservation measures on a basis dependent upon the long term employment of returned men. We hope that these men will as rapidly as possible return to civilian life in activities for which they are best suited and under congenial surroundings of their own choice.

Conservation activities on the other hand should become part of a permanent program. The public is conservation-minded at the present time. Our farmers have seen their top soil carried from their fields by erosion. The loss of forest cover has resulted in spring floods and summer drouths. Stream flow has diminished and wells have dried up. The sportsman and nature lover has seen the habitat of fish and game, tree, shrub and flower disappear in all too many areas.

Half measures are not good enough. Scientific planning and effective execution of those plans provide the only rational basis of action. All agencies must work together in such projects for it is perfectly obvious that the boundaries of agriculture, of forestry, of

water control and preservation of wild life overlap one another. They cannot be contained in separate compartments and the problems of each treated as an entity, but each must be considered as a segment of the large problem of conserving our national heritage.

In conclusion, I should like to say how much we are heartened by the vigor and determination evidenced by the present Government in setting up a new department, namely, that of Planning and Development to handle conservation problems, and the Guelph Conference and the organizations it represents pledge their individual and collective co-operation in the prosecution of worthy projects.

10

"STREAM SANITATION"*

Dr. A. E. Berry
Director of Sanitary Engineering Division,
Ontario Department of Health, Toronto

THERE is an early concept that every riparian owner has an inherent right to the use of the waters of a stream, but on condition that the water returned to that stream will be in as good condition as when it was abstracted. He thus does not jeopardize the rights of others on the same watershed. This situation prevailed in the early days, without much difficulty. As populations increased, industries developed and the country was altered so that run-off became more rapid, this obligation was abrogated in order to avoid expense and the inconvenience of waste treatment.

Stream sanitation is a co-operative responsibility, equally applicable to municipalities, industries and private citizens. It behooves each to adhere as closely as possible to the original understanding of adequate treatment of used or processed water before its return to the stream. Cleanliness may be considered a measure of civilization, and clean, clear water suitable for drinking, fishing, bathing, recreational purposes, as well as for industry and agriculture should surely be the heritage of every Canadian, and especially those in this province so richly endowed by nature with surface waters.

Protection of streams for the full use and enjoyment of all the population is an ever present problem, as well as a difficult one. All too frequently we have strayed far from national cleanliness. A foul ill-smelling water-way, unsuited for domestic use, is a grievous reflection on the intelligence, altruism and progressiveness of a community and its individual citizens. The time is now at hand when all countries must not only call a halt to further pollution, but must eliminate that now taking place.

SANITATION AND RIVER DEVELOPMENT

Stream pollution is intimately related to river valley development. Low flows, coupled with high summer temperatures, greatly intensify the problem for the sanitarian. Heavy spring run-off may have a momentary action but it is of minor value in stream sanitation. Any development of a river valley which will tend to retard this high run-off for use in the hot weather, when low flows usually occur, assists greatly in the maintenance of the stream. In fact all treatment of

*Presented by G. A. H. Burn, Associate Sanitary Engineer
Ontario Departmentof Health, Toronto

sewage and other wastes is predicated on some dilution in the receiving stream, and the greater this is, the more effective become the results.

With this thought in mind it is apparent that stream conservation must be justified in no small measure on the improvement to be achieved in sanitation. Flood control may be highly significant in some watersheds. Soil erosion may predominate in others. As between these factors, in the Grand River project, it was generally agreed that sanitation was the more important. The specific requirements in each watershed will determine the relationship between sanitation and all other needs.

RIVER VALLEYS IN ONTARIO

The Province of Ontario contains a number of prominent watersheds. The Great Lakes waterway is known throughout the world, and is the largest body of fresh water found anywhere. Forming part of this as well as draining into it are a number of major rivers. Northern and north-western Ontario are likewise well supplied by rivers, but these seldom create the same problem in sanitation as those in the older parts of the province.

The Water Power and Hydrometric Bureau of the Dominion has reported on the annual flows of many Ontario streams. In southern Ontario these watersheds are listed under the following basins:—*Lake Superior Basin*, including Pigeon River, Matawin River, Kaministikwia River, Nipigon River, Magpie River and Montreal River; *Lake Huron Basin*, including the rivers Mississagi, Spanish, Aux Sables, Vermilion, Wanapitei, Sturgeon, South, Magnatawan, Muskoka, Black, Beaver, Rocky Saugeen and Saugeen; *Lake St. Clair Basin*, including the different branches of the Thames River; *Lake Erie Basin*, including the Grand River Tributary Basin—the Speed and Grand Rivers; *Lake Ontario Basin*, including the Niagara, Credit and Moira rivers; *The Ottawa River Basin* (Ontario Tributary Basin), including the Ottawa River, Montreal River, Petawawa River, Bonnechere River, Madawaska River, York River and Mississippi River.

In northern Ontario the *Southern Hudson Bay drainage basins* including the Kenogami, Missinaibi, Mattagami, Groundhog, Kapuskasing and Abitibi rivers are of concern more for power development than sanitation.

In north-western Ontario, we have the *Winnipeg River Basin*, including Winnipeg River, Namakan River, Turtle River, Rainy Lake, Lake of the Woods, English River, Lac Seul, Wabigoon River and Whitemouth River. This drainage area receives a considerable degree of industrial and sanitary wastes at Fort Frances, Rainy River and Kenora.

It will be noted that there are a number of other streams contributing to the above basins for which flow records are not available.

All these drainage basins present wide fluctuations in flow con-

ditions. Sanitation becomes acute when the stream flows are reduced to a low point, and since this usually occurs in the summer it combines to make the worst period for stream sanitation.

Each river basin has its own special problems. Some must carry large quantities of wastes in spite of the fact that the waters are needed for many functions. Information as to stream flows is therefore essential. Where high flows continue throughout the year, as in rivers like the St. Lawrence, Niagara, St. Clair and the Ottawa, the problem of waste disposal is greatly simplified. The opposite to this is found in streams of variable rates like the Thames, the Grand, the Ganaraska, the Speed and others. Here the organic wastes may reach such a figure as to completely upset the oxygen balance at low flows.

It is unfortunate that many of these streams of a flashy nature traverse areas which are thickly populated, and highly industrialized. It is probably fair to say that this may have led to the present condition in the streams, and we are consequently travelling in a circle of cause and effect, the results of which have national importance.

It must not be assumed, however, that stream sanitation is a problem only in those watercourses of wide fluctuations and low seasonal flows. Pollution may be detrimental and difficult to control in the larger rivers as well. This is becoming more evident in recent years with the growth of industrial processes. Some of these wastes are of such nature that they can exert a deleterious effect on the water even when present in very considerable dilution. A similar situation may arise in lakes where there is no persistent current but only that induced by winds.

In this conference on river valley development it will be obvious that first consideration should be given to those streams with flash flow characteristics. We need go no further afield for illustrations than the Thames, the Grand and the Ganaraska rivers, as well as their tributaries. Probably greater study has been given to these three rivers as conservation projects than any others in the province. They may accordingly be regarded as presenting the major problems likely to arise in stream sanitation.

SANITARY PROBLEMS IN RIVER VALLEYS

In dealing with the problems of stream sanitation it is well to appreciate at the outset just what use is to be expected of rivers. If it is accepted that these waters are for the use of all, and it is diffiuclt to reach any other conclusion, then we must ensure that they will be available for drinking water supplies, for industrial use, for agricultural purposes, for recreation and for beautification of the country. Every stream does not have to meet all these needs, and under those circumstances there is a tendency towards modification of treatment standards.

It is well, however, that there be public recognition of the fact that the quality of the stream should in no way be injured by the discharge of wastes or other foreign matter.

Utilizing as examples the three river beds previously mentioned it will be seen that on the Ganaraska municipal water supplies are not at present a factor, but other uses must be made of this stream. In the Grand river the communities on the upper reaches obtain water from the underground, but lower down Brantford and Dunnville must rely on the river water for all purposes. Were these positions reversed the problem would be less difficult. Again in the Thames river underground sources are at present used for all communities until Chatham is reached in the lower part.

WATER SUPPLIES FROM RIVERS

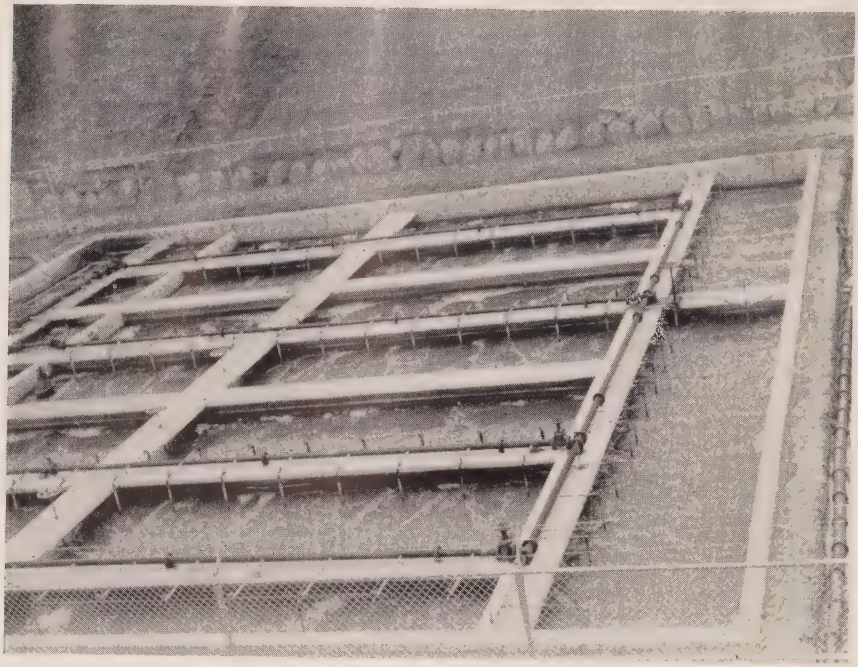
Domestic water supplies require the highest standards of river quality, and if a stream is needed for this purpose a high degree of treatment of wastes will be called for. This involves not only sewage, but all industrial by-products. Treatment of these wastes from industries is not always easy, and it is conceivable that some streams may become entirely unfit for drinking water in spite of waste treatment. The adoption of conservation measures which will retard the run-off will have a most beneficial effect in this programme.

In some countries a policy has been adopted of limiting streams for specific functions. Some would be maintained so that they could be used for drinking purposes, while others would be allowed to deteriorate in quality. This policy has not been adopted in Canada, but rather it is hoped that all watercourses can be retained in good condition.

SEWAGE DISPOSAL

There is no alternative to the discharge of sewage and other wastes into streams when these liquids are produced in substantial quantity, and it then becomes a problem of providing adequate treatment. The methods of sewage treatment have now been developed to a high degree of efficiency, and we can say that measures are available for handling domestic sewage and for protecting the watercourse accordingly. The same is not always applicable to industrial wastes without much expenditure.

Treatment of sewage and other wastes has not been adopted in this country to the same extent as water purification. There are probably several reasons for this. In the early days the treatment of sewage was not developed as far as water purification and there was more tendency to postpone the necessary works. Expenditures for sewage disposal are seldom popular items since they have come out of general taxation instead of being paid as a separate account similar to water rates. Then again many municipalities have for years dis-



Ontario Department of Health Photograph.

Part of a modern sewage treatment plant designed to protect stream sanitation.

charged these wastes either raw or only partially treated into the nearest watercourse. The correction of this is a greater problem the longer it continues.

SEWAGE TREATMENT IN ONTARIO

Some figures on sewage treatment in Ontario may be of interest. While a good deal of progress has been made, there is much more to be accomplished, and it is anticipated that an extensive programme in this field will be carried out in the post-war period.

There are 144 municipalities in Ontario that have public sewer systems. These represent a population of 2,297,000 or about 59% of the total population in the province. This percentage is higher than that in any other province, and the corresponding figure in the United States is 55%.

The percentage of the sewered population in Ontario from which raw sewage is discharged is 30, as compared with 50 for the United States. The figure for Ontario is more favorable than most provinces and States, and this is in spite of the fact that we have larger bodies of receiving water than available in most other places.

The fact that this figure for Ontario possesses some relative advantage does not preclude recognition that there is a good deal yet

to be done in treatment of sewage both in those municipalities now having public sewers and those which later will install this utility.

RECREATIONAL FEATURES

Due consideration must be given to the use of our streams for recreational purposes. Ontario possesses many attractions for the tourist, but to take advantage of this it will be essential that recreational use of our waters is assured. Pollution which endangers bathing is detrimental to national welfare. The same applies equally to fishing. Contamination which destroys fish in a stream is to be actively attacked. It is well that all should appreciate the fact that streams are a national asset, and they are not to be degraded in order that a few may enjoy some economic advantages.

NUISANCES FROM ALGAE

There is another problem that in recent years, has become more prominent, and has given a good deal of concern to those who are interested in clean streams. This is the presence of a vegetable growth known as algae. It may also be associated with higher plant forms growing as weeds in the water and creating an adverse appearance.

Algae is not unlike any crop which grows on land. It is seasonal, and it depends on proper fertilization and environment. The extent to which this growth occurs will be related to these local factors. In some places it has developed to such an extent that when decomposition set in it produced most offensive odors. In other places it has formed a scum on the water.

This green plant is not injurious, in spite of the objection raised by some people, so long as it does not accumulate in confined bays and decompose. There are instances recorded where for some species this has proven poisonous to live stock. Some people do not like bathing in waters which contain algae. No doubt it is preferable to have a stream free of this if it is possible.

Algae requires fertilizer in the stream, but this can usually be obtained in the run-off from agricultural lands. The relationship between the growth of algae and the presence of sewage is an interesting one. The public quite frequently mistakes this growth for sewage. Green algae does not grow in a stream where the oxygen has been depleted by the presence of sewage, but it does grow luxuriantly in the stream farther down where the injurious effect of the sewage has been dissipated. Here the sewage has added fertilizer to stimulate the growth. Unfortunately this is certain to take place even if the sewage is highly treated before it reaches the stream. Rivers which receive sewage and other wastes are annually carrying away large quantities of plant food and the algae are merely taking advantage of the presence of this. There is very little that can be done to prevent it, although the algae may be destroyed by chemical treatment.

AGRICULTURAL DRAINAGE

The use of rivers for agricultural purposes is a national asset and it is an advantage of no small importance to have access to a clean stream. The obligation to maintain the water in this condition applies here as well as to municipalities and industries. All too frequently there is a tendency for some farmers to regard rivers as an outlet for all wastes, and for the disposal of dead animals and other debris. It is difficult to maintain supervision over such misdemeanors, and unless the riparian owner takes an interest in stream sanitation, and observes the rights of others this problem is likely to continue in spite of police regulatory measures.

UNDERGROUND WATER SUPPLIES

For a large part of the population underground waters constitute the only source of supply. This is true not only for urban centres but for rural areas as well. For this reason it is essential that steps be taken to maintain the quantity as well as the quality. Much will depend on the nature of the underground itself. Where this is absorbent and porous the supply will be replenished more readily, but there may be a greater opportunity for pollution to travel.

By conserving our streams and holding back excessive run-off much can be done for underground waters. The fact that these supplies respond to the seasons and to pumping from other wells emphasizes the need for river valley development.

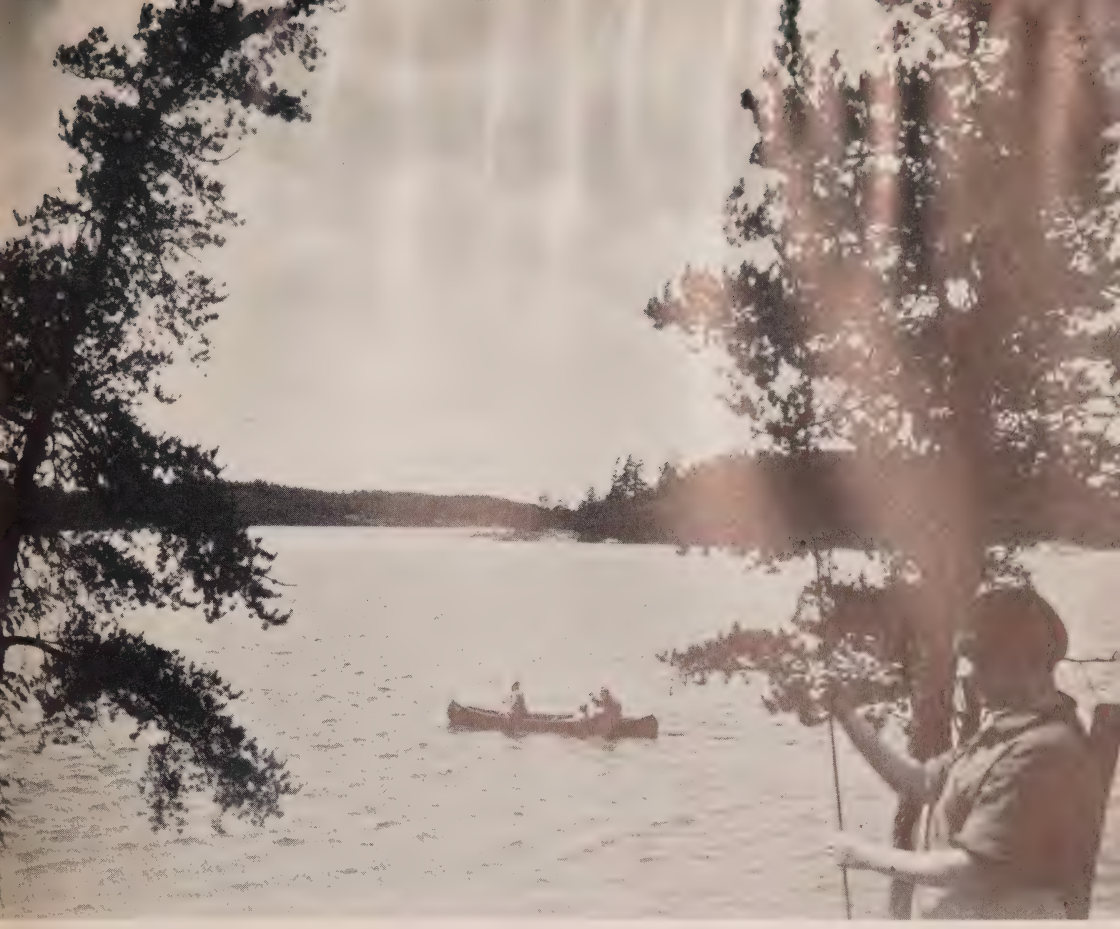
The provision of sanitation for the underground is not so great a problem as in surface waters, except in those formations where filtration of the water will be inadequate. Under some conditions it is known that pollution will travel substantial distances.

THE GRAND AND THE THAMES

Since this conference is being held near the Thames River, for which legislation dealing with conservation measures has already been passed, it may be well to discuss the probable results to be obtained. This can be predicated in a measure on what has been accomplished on the Grand River.

Before the Grand River Conservation Project was completed great difficulty had been experienced in overcoming offensive conditions in the summer when low water combined with the discharge of sewage and other wastes. During dry seasons the flow in the river was so low that it was only equal to about the quantity of sewage reaching it. This would have created a difficult situation even if all the sewage had been thoroughly treated.

By the construction of water storage facilities this extremely low flow has been overcome. The river has been improved, and economy has been brought about in the treatment of sewage. This project has



Ontario Department of Health Photograph.

Stream sanitation makes for enjoyable recreation.

been thought of as one intended to prevent offensive conditions in the stream. So long as large quantities of sewage reach the river even this higher flow will not create an ideal environment, but it does bring a considerable improvement.

Conditions along the Thames River are to some extent similar to those on the Grand. Both are subject to low flows in the summer. The branch which flows through St. Marys receives the discharge of the Avon River which in turn carries all the sewage from Stratford. St. Marys and Mitchell will later have to discharge sewage into this stream.

The other branch of the Thames is subject to sewage wastes at Ingersoll, Woodstock, Dorchester and Thamesford.

When London is reached the Thames receives the sewage from a large city. This is treated, but this same water must be used for drinking purposes at Chatham, after which it receives more sewage, and in this instance untreated.

This situation is not a desirable one, but it is apparent that there is no alternative to the use of the stream as a sewage outlet, and a source of water supply for some purposes. Two procedures can help in the sanitation of this water. One would be to treat all sewage wastes thoroughly, the other to prevent low stream flows. Proper development of the river valley is therefore an important problem in the control of this stream.

An increase in stream flow can do much to remove excess algae growth, where other methods fail. In rivers where the edges of the banks are rough and pools form there is an opportunity for algae to grow, and for wastes to stagnate. This was the situation in the Grand before the Conservation Project was completed.

RIVER VALLEY DEVELOPMENT

It will be apparent that river valley development is linked closely to stream sanitation. The immediate problem is to secure necessary legislation, combined with initiative on the part of those who are to benefit.

Special legislation has been passed in Ontario to deal with both the Grand River and Thames River developments. This is a requirement to set up the administrative machinery for financing and carrying to completion the necessary construction work. Other legislation also enters this problem. It must deal with the control of pollution and assist in the maintenance of clean streams. This authority is contained in The Public Health Act of the province. Under this Act supervision of stream sanitation comes under the direction of the Department of Health.

In line with this responsibility it is anticipated that the post-war period will see major improvements in the disposal of sewage, industrial wastes and other refuse. Here, the objective cited at the outset must be kept in mind—to maintain clean streams and to so observe the rights of others that our rivers will be available for all uses throughout their entire course.

DISCUSSION

MR. LESLIE HANCOCK, GUELPH: Dr. Berry gave figures on 144 municipalities. Then he mentioned treating raw sewage and treated sewage but he did not mention dried sewage. I believe some of it is dumped in as treated sewage. I believe some municipalities in the United States, such as Minneapolis and St. Paul, have large drying systems. I would like to know if there are any municipalities in Ontario which have drying systems which do not put the sewage in the rivers at all?

MR. BURN: When you speak of drying systems, even in the United States I do not think that includes the drying of liquid waste which comes from the municipalities. I think you will find they all discharge liquid waste. The drying process is the dewatering of the sludge or the solids which are removed from the sewage during the treatment process. We have a number of municipalities in Ontario which dewater their sludge mechanically. Scarboro, York Township, and Long Branch. There is no sludge

Ontario Department of Health Photograph.

Accumulations of algea on a lake shore sometimes decompose and produce foul odours.

drying done in London. Other plants use covered or open drying beds, such as at Kitchener. There are some places—such as for instance, Milwaukee in the States, where they dry their sewage sludge and it is used to make fertilizer.

So far as drying the entire waste is concerned, the operation would be too costly for any municipality to undertake. They may dry the solids for the use as fertilizer or for disposing of them more effectively but they do not attempt to evaporate all the liquid which comes down the sewers.

MR. HANCOCK: May I ask how they return water to the river in as pure a condition as it is taken out?

MR. BURN: You can't, entirely, without going to extensive methods of purification. There is this point though to be borne in mind, that the treatment process is predicated on the amount of dilution that you have in the stream. As soon as contaminated water reaches the stream, natural purification processes begin to work and it is the purpose of the engineer in designing the sewage disposal system to take advantage of nature as much as he can. If the purification which is provided is sufficient to insure that by the time the water reaches the next user it is in as good condition as it is taken from the upper municipality, then the question of sewage purification has been satisfied.

MR. BRUCE BRADLEY, KENT COUNTY: I have two questions I would like to ask. One: What does effective treatment of sewage as now practised by the municipalities of Ontario, cost per person of the inhabitants of the municipalities affected?

In other words, how big a cost is it to do the job?

Secondly, I live sixteen miles below Chatham on the Thames River and it is customary for all the children in our neighbourhood to swim in the river. The common rumour is that in so many miles, about seven miles of open river, sunshine and other factors clean up the pollution of raw sewage from the City of Chatham in the Thames. Have you any idea with very low or very little current in the summer, how many miles it takes to purify sewage so that it is not dangerous for bathing. They are bathing in it and they have been doing it for thirty years.

MR BURN: With regard to your first question, as to the cost; that depends upon the type of treatment required. With greater dilution, the degree of treatment required is usually less. The per capita cost will vary anywhere from perhaps $2.50 to $12.00 or $15.00 per capita, depending upon the type of treatment.

MR. BRADLEY: That is the total cost?

MR. BURN: The cost of purification works.

MR. BRADLEY: Annual cost or capital cost?

MR. BURN: That is the capital cost. With regard to the second question, as to the self purification of streams, I don't think anybody can answer that question satisfactorily. It depends on so many factors—the amount of contamination you introduce into the stream, the amount of dilution provided, the rate of flow and the temperature and weather conditions. As far as bathing is concerned, anybody who bathes in any natural water is subjecting himself to some potential health hazards. Once you get in the water yourself you contaminate it. If you want to have absolutely safe bathing the only place to go is into some artifically constructed pool where the water is recirculated and chlorinated and a residual chlorine maintained to destroy the contamination which you yourself introduce. However, that would be pretty hard for a lot of us who want to go bathing. The chief danger from any water of that kind is to a person if he swallows it. If you have children bathing in natural water, impress upon them that they keep their mouths closed and don't take that water into their digestive tracts and in all probability nothing of a serious nature will take place. Bathing in the immediate vicinity of a sewage outfall, of course should not be permitted, but when you get some distance away from the outfall and the sewage has been mixed with the stream and certain of these natural purification processes have started, then the danger is largely removed unless you actually drink the water.

MR. WATSON, INGERSOLL: Is it true that the Provincial Department is making it compulsory for municipalities that are contemplating sewage systems to put in drying beds for the sludge?

MR. BURN: I don't know that we are making it compulsory, but any system of sewage purification results in sludge being formed and collected and that has to be disposed of. It may be disposed of on the drying bed or it may be disposed of by artificial methods of drying with filters and presses.

If the situation is such that the sludge can be removed to some place where it will not create a nuisance in liquid or semi-liquid form, then I don't think there would be any objection to that, but drying beds or some form of drying is usually complementary to a sewage disposal plant.

MR. C. A. WALKINSHAW, TORONTO: Since this new Department of Planning and Development is looking and trying to limit or enlarge their view of things and find out the facts, I want to perhaps in all modesty, just call the attention of those interested to this remarkable paper of Dr. Berry's, and I think Mr. Burn has been very, very kind in answering the questions so fully. However the recreational features stressed by Dr. Berry haven't been stressed sufficiently in some other papers we have listened to, and there are a great many sportsmen in the Province who have a feeling that bathing, fishing and hunting are an important part of our national life and are perhaps going to be even more so when our men come back from the front. Therefore I would like to say to Dr. Langford that I hope this paper will be given very serious consideration. We have thought of a lot of problems, in connection with conservation but this one is most essential. I think Dr. Berry's paper should be given the most careful consideration.

MR. MCKAY, PERTH COUNTY: I took great pleasure in listening to the paper written by Dr. Berry and read by Mr. Burn. We live below Stratford and we have had some considerable difficulty this summer and I am glad to hear the Department is going to take steps to try and remedy it.

MR. JOHN W. IRWIN, TORONTO: This is changing the subject somewhat, and is a question I wanted to ask the chairman as a member of the Grand River Commission. Does the Grand River Commission take any responsibility or feel any responsibility as far as soil erosion prevention and so on is concerned in the drainage into the Grand River, which is now to some extent protected by the dam, and on which more dams are to be built?

CHAIRMAN PHILIP: The Act under which we operate allows us to deal with the river, its conservation and its effect on sewage. It doesn't mention soil erosion, but the Commission itself is intensely interested in soil erosion and reforestation and all that this Convention has brought up. In fact, we have already started in our own river valley from Port Maitland to the Georgian Bay, an Association which is interesting itself in all these problems.

MR. JOHN W. IRWIN: In connection with silting in the lake above your dam, have you been assured by the engineers there is no likelihood of this? It has happened in many cases in the United States that there have been large expenditures on dams and they have been silted up in perhaps five or ten years.

CHAIRMAN PHILIP: The construction of our dam is such that the water that is being released comes from the bottom of the dam, not the top of the dam. The pressure of about 70 feet of water above it we feel will flush out any silting that occurs. We aren't fearful of silting in the dam.

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GRAND RIVER CONSERVATION

E. F. Roberts
Secretary-Treasurer, Grand River Conservation Commission, Brantford

HISTORY

THE Grand drainage basin comprises some 2600 square miles commencing about 30 miles south of Georgian Bay near the Village of Dundalk and extends in a southerly direction to Lake Erie. The elevation at its source is 1700 ft. above sea level and drops to elevation 572 at Port Maitland on Lake Erie. The principal streams contributory to the Grand River are the Irvine, Conestogo and Speed Rivers, Galt Creek, Nith River and Whitemans Creek, all emptying into the upper or central part of the Grand above Brantford. The lower course of the Grand has five tributaries, the Fairchilds, McKenzie, Big, Boston and Rogers Creeks. The course of the Grand extends for 180 miles and dependent in whole or in part on this drainage system are the Counties of Grey, Dufferin, Wellington, Waterloo, Perth, Halton, Oxford, Wentworth, Brant, Norfolk and Haldimand.

As was the case in most rivers, the Grand played an important part in the early development of the country providing one of the main water routes to and from the interior. For some years it was the principal shipping route for lumber and grain and passenger service between Brantford and surrounding district to Buffalo and Lake Erie ports. Due in no small measure to the access afforded by the River, settlement along the Grand was rapid and many villages were established and grew lustily on the rich harvest from the fertile soil and magnificent stands of timber.

In the course of all too few years most of the timber was cut and clearing of the land for agricultural purposes and the establishment of drainage systems to prepare more land for farming created a decided change in the flow of the Grand. From a full flowing lusty river it gradually developed into one of very high flowage in the spring and one of very low flowage during the summer, fall and winter months. This change meant large expenditures on the part of some of the municipalities for flood prevention works and a high annual loss in others due to flooding.

PRESENT POPULATION

Now the Grand River Valley has a population in excess of 350,000 people and is the most densely populated and greatest in industrial wealth of any comparable area in the Dominion. It was axiomatic,


GRAND RIVER
DRAINAGE BASIN
PROVINCE OF ONTARIO
Total Area ~ 2600 sq. mi.
Scale
0 5 10 15 20
Reference
Storage Areas
Drainage Area boundary
Watershed boundary
County boundary
Swamp or marsh
Cities
Towns
Villages
Hamlets
GREY
DUFFERIN
WELLINGTON
PEEL
HALTON
WENTWORTH
LINCOLN
HALDIMAND
NORFOLK
OXFORD
BRANT
PERTH
WATERLOO
LAKE ONTARIO
LAKE ERIE
Dundalk
Luther Marsh
Amaranth Swamp
Grand Valley
Waldemar
Dufferin Lake
East Garafraxa Swamp
Proposed Hollen Storage Drainage Area 189 sq.mi.
Proposed Waldemar Storage Drainage Area 267 sq.mi.
Arthur
Belwood
Drayton
Shand Dam (Constructed)
Fergus
Hollen
Elora
Irvine R.
Grand R.
Conestoga R.
ELMIRA
Proposed Elora Storage Drainage Area 472 sq.mi.
Eramosa R.
Conestoga
GUELPH
Bridgeport
Breslau
WATERLOO
KITCHENER
Freeport
SPEED R.
Galt Cr.
HESPELER
Puslinch Lake
Drainage Area above Galt 1360 sq.mi.
New Hamburg
Blair
PRESTON
Beverley Swamp
GALT
Nith R.
Ayr
Hamilton Harbour
Burlington Canal
Fairchild Cr.
Horner Cr.
PARIS
Canning
BRANTFORD
Whitman Cr.
McKenzie Cr.
Caledonia
Boston Cr.
Drainage Area above Brantford 2000 sq.mi.
Cayuga
DUNNVILLE
Port Maitland
N

therefore, that within this area there would be sufficient men of vision and public spirit to recognize the importance of the Grand River drainage system to all within its environs and take the necessary steps to improve and conserve this vital resource.

GRAND RIVER VALLEY BOARDS OF TRADE

The first step in conservation within the Grand was the formation of the Grand River Valley Boards of Trade in 1931 representing a number of Municipalities along the Valley and the petitioning of the Provincial Government by that body to enquire into ways and means of flood control and water conservation within the Valley. With the approval of the Minister of Lands and Forests and the Chairman of the Hydro-Electric Power Commission, Mr. James Mackintosh carried out a survey and prepared a report under date of February 11, 1932, with subsequent surveys by Mr. Otto Holden of the Hydro-Electric Power Commission and Mr. J. L. Morris of the Department. The Mackintosh report was most thorough and in substance indicated that control of floods and conservation of water was feasible at moderate costs and further that as industrial and municipal development increased, the demand for water would increase especially so for the dilution of sewage and industrial waste.

GRAND RIVER CONSERVATION COMMISSION

To carry out the work of conservation the Grand River Conservation Commission was granted letters patent in 1938 and Commissioners appointed from eight municipalities. In the same year, having decided on a general conservation plan embracing four units, one on the Grand above Fergus, one at Luther Marsh, and one each on the Conestogo and Nith Rivers, negotiations were started with both the Dominion and Provincial Governments with a view to arriving at a division of costs for the first two units of the plan.

GRAND RIVER CONSERVATION COMMISSION ACT

In 1938 the Grand River Act was passed providing for conservation within the Grand River and tributary streams and actual work got under way in 1939.

ALLOCATION OF COSTS

The Dominion and Provincial Governments each agreed to pay 37½% of the costs, the remaining 25% to be paid by the participating municipalities. Predicated on proportionate benefits accruing thereto the percentage chargeable to the municipalities was as follows:

Brantford	38.43%
Kitchener	28.76%

The City of Galt, Ontario, during the flood of the Grand River, 1912.

Galt	16.25%
Waterloo	6.00%
Preston	4.27%
Paris	3.47%
Fergus	2.02%
Elora	.80%

PLANS

One of the first steps taken by the Commission was to secure the services of Dr. H. G. Acres as Chief Engineer of the Commission and under his supervision final surveys were made and plans and specifications prepared for No. 1 unit. Principally because the most good could be accomplished for the least expenditure, the site for the Grand Valley Dam was determined at a point on the Grand about 2½ miles north of Fergus. This unit was completed in August 1942. The second unit authorized but held in abeyance till after the war at the request of the Governments is the Luther Marsh project located in Dufferin County some 30 miles north of the Grand Valley Dam.

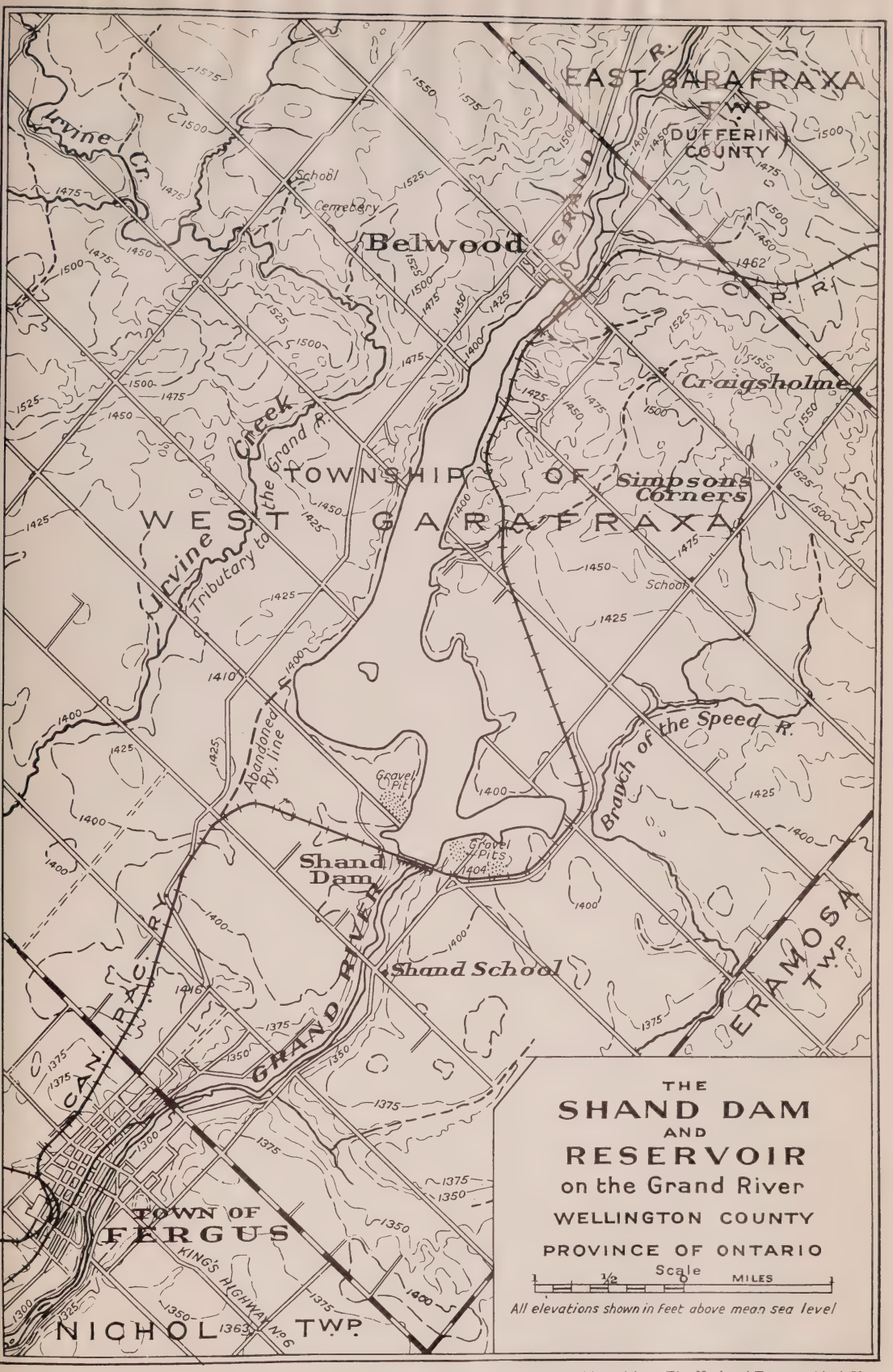
The presently completed unit provides 46,000 acre feet storage

Aerial view of the Grand Valley Dam and lower end of Lake Belwood with 46,000 acre feet in storage.

and the Luther project will, when completed, augment this by 10,000 acre feet.

FLOOD 1943

During the run–off in the Spring of 1943 our newly completed dam ably demonstrated its value for at that time the upper river run-off was 63% in excess of any known record. The run-off from tributary streams lower down the river was comparable and had the crest of the upper river and lower river floods been permitted to coincide, all previously known flood records would have been greatly exceeded and inestimable damage done to property bordering the river. As



Adapted from The National Topographical Map.

Map showing Lake Belwood and its environs.

it was, sufficient of the upper river crest was impounded and the level at Brantford held to 1.7 ft. below the 1929 peak (1929 being a record high for 30 years).

COST NO. 1 UNIT

The construction of No. 1 unit entailed the purchase of some 3200 acres of farm lands and village property costing $279,600.00. the building of 6½ miles of railway to replace part of the C.P.R, Elora sub-division at a cost of approximately $345,000.00 and a number of road diversions around the flowage area. The total cost of the project including $10,000.00 allocated for reforesting certain areas owned by the Commission amounted to $2,056,487.01.

FLOW RATE

Intensive study has and is still being given the matter of low flow regulation and it now seems that additional storage is necessary if adequate water for dilution of sewage and industrial waste for the constantly increasing population is to be provided; only the minimum can be maintained with our present storage and when abnormal conditions prevail as they frequently do in the best of regulated disposal plants the added demand on our storage is serious.

This year, I think, may be considered an average year in so far as precipitation is concerned, the stream flow in all rivers would, therefore, be about average. In the Grand we started as soon as the run–off occurred to impound water behind the dam and soon had full storage at elevation 1394.6, this being the top elevation of the main gates at the dam. It was then routine to pass through the valves the same flow as entered the storage from the upper river. On June 14th it was considered necessary to flush the river to remove the accumulated algae which had reached the stage where an objectionable odor was noticeable. The first flushing was done using a flow rate of 3000 c.f.s. for a period of 15 hours, this represents a total of 1,672,500,000 gallons of water; the results obtained by this method of cleansing the river channel were satisfactory and subsequent flushing was carried out at two week intervals using 1500 c.f.s. for 10 hour periods till about the middle of September. Between flushing periods the valved flow was established at 70 c.f.s. in June to maintain a minimum flow of 200 c.f.s. at Doon and was gradually increased during the months of July, August and September till a valved flow rate of 370 c.f.s. was reached. Approximately 28 hours elapse between the time water is discharged at the dam and its arrival at Brantford.

The object in flow regulation during the summer is, of course, to maintain sufficient water for dilution of sewage and industrial waste and the removal of algae and weed growths. Coupled with this is the very important but little known or recognized function of replenishing

underground water tables on which no small percentage of our population depend. One gets some idea of the very considerable amount being fed to underground supplies by noting the difference in c.f.s. passing gauging points along the river. There is also the maintenance of flow rates for the many power dams along the river and the prolongation of these rates for as long a period as possible, all of which means a distinct saving to the mills in steam or electric power costs.

LAKE BELWOOD

Lake Belwood apart from providing us with 46,000 acre feet of storage (12,483,000,000 gals.) is fast becoming a popular resort; the Commission have set aside a number of lots which may be rented at a very moderate rate for a term of ten years and a number of cottages are already built or building. Boating is very popular and numerous small yachts are in use during the summer.

Service Clubs of Kitchener and Guelph have established Boys Camps on the Lake and it is anticipated others of like nature will follow; all told about 70 applications for lots have been received since opening up the property this year.

The Commission are preparing camping and picnic grounds, parking lots, rest rooms at or near the dam for the use of the many visitors from all parts of the country. Reforestation and landscaping is being carried out as quickly as labour conditions permit, some

Headwaters of the Grand River in summer—East Luther Township, Dufferin County.

Photograph by A. F. Coventry.

80,000 trees have already been planted and as time goes on it is hoped that all marginal land not required for cottages or other use will be reforested.

I have in the foregoing endeavoured to outline briefly the history and accomplishments to date within the Grand. These works have not been brought about without mistakes. The first was a matter of timing and the war and necessitated closing down construction work for a short period till the grants promised by the Federal Government were assured and construction again carried on. No one is to be blamed for this but it may be taken as a gentle reminder that groups undertaking similar works make sure of their continuity of grants.

The second and biggest mistake was the thought in so many minds that a major undertaking of this type could not, with a multiplicity or municipalities participating, be carried out to a successful conclusion. The whole hearted co-operation and unanimity of purpose of all the municipalities and that of the numerous Dominion and Provincial Ministers and their staffs have proven once and for all that any major conservation project designed to conserve our natural resources and maintain this land of ours the best homeland on earth can be accomplished by those with the courage to try.

DISCUSSION

MR. E. F. ROBERTS (closing remarks): In conclusion, Gentlemen, may I say to think is to act as far as Grand River Conservation is concerned. We have long recognized the fact and came to the conclusion that in order to put forward the work of conservation within the Grand we should have everybody that is conservation-minded co-operating in the movement.

To that end the Commission invited representatives, either Wardens or Reeves or other representatives from the Counties of Grey, Dufferin, Wellington, Waterloo, Brant, and Haldimand to attend a meeting of the Commission just a few days ago. It was explained at this meeting that it was thought from our experience in conservation work it would facilitate matters greatly if all organizations would band themselves together in a geographic group, in a group comprising a main drainage area, like the Grand. We thought contact with the Government would be easier because there would be a planned and orderly continuity of thought and work, and we asked these gentlemen their opinion.

I am very happy to say that the representatives from all of these Counties have now instructed the Executive of the Commission to prepare for and call a general meeting of everybody within these Counties, and any other adjacent counties, that wish to participate in general conservation work. This also includes Rod and Gun Clubs, the Press, the Hotel Keepers' Association, Road engineers, etc., because we are just as much interested in developing the area from the standpoint of scenic roads and potential camping sites as we are in conserving the water, and I might say that this Association of Conservation groups is now in the process of being formed.

MR. C. W. HELMER: I would like to make the suggestion that the planting be carried out along our north and south roads in Ontario. If six rods were taken off on one side of the roads and planted with trees it would provide plenty of work for returned men and stop the hot drying winds of summer.

MR. W. H. RIEHL, STRATFORD: I would like to know from the people who live in the Grand Valley if they could tell us something about their requirements in connection with stream pollution.

MR. E. F. ROBERTS: The minimum flow requirement in the Grand at the present time, established by the Department of Health, is 200 cubic foot seconds at the gauging station at Doon. That is considered the minimum flow rate required to provide the minimum dilution and we have, with our one unit, been able to maintain 200 cubic foot seconds at that gauging station. That is the requirement for normal conditions.

However abnormal conditions occur sometimes on every stream. For instance in this present year we were called upon because of an isolated case, to deliver a flow rate very much in excess of what the storage facilities at the present time provide, but by lowering the lake a little faster than we like to see it lowered, we were able to carry on for the short period required. But as industrial population increases the storage we now have will not be adequate. For that reason we are planning to build three other units to take care of the rapidly increasing water requirements for diluton.

MR. H. F. BENNETT, LONDON: I would like to ask Mr. Roberts what is the lowest elevation of his poundage this year, which he considered an average year—to what level was it lowered during 1944?

MR. E. F. ROBERTS: We started off with the full poundage at elevation 1396.4. We are now down to elevation 1374. That is what is utilized so far.

CHAIRMAN DETWILER: Might I ask the speaker if the dam at Fergus is a single purpose, constructed as such, or a double purpose dam?

MR. ROBERTS: It is very definitely a double purpose,—flood prevention and sanitation. The protection of property, I believe, and I think the rest of the Commissioners will agree with me, is secondary.

CHAIRMAN DETWILER: Will you also permit me to ask how the flushing of the stream during intermittent periods effected wild life in the stream? I imagine the water rose and fell very suddenly. Did it interfere with the feeding of the fish, if you have any in the Grand?

MR. ROBERTS: That is a moot question about fish in the Grand. There are some, of course. But these problems must be studied and the correct method of operation is a question of trial and error. Now, frankly, we didn't know, and there was nobody could tell us how many cubic foot seconds is required to cleanse the river. We started off, as I told you, with 3,000 cubic foot seconds, that sends a crest down the river and gradually dissipates itself until when it arrives at Brantford the crest is only a very moderate increase in the river level. Starting off and going through some of the upper reaches of the Grand, for instance, through the Elora rocks, there is a very decided crest.

We found out from the first experiment we didn't require 3000 foot seconds to clear the river properly, and we gradually reduced that to 1500. After a year's operation it appears 1500 is somewhere near the right amount. We hope we will be able to use less water than that, but we haven't gone sufficiently far to know we can use any less.

As far as the effect on game life, presumably you mean fish—I don't give any credit to the reports circulated. I can't see why adding a few cubic feet seconds to any stream would have any effect—carp included.

CHAIRMAN DETWILER: The fish food lives fairly close to the surface. When you get above that level you get above where the fish food chiefly lives. I imagine it would disturb them. I suppose that is neither here nor there with the Grand.

I think when you get the other units established, which we hope will be a post-war project, you will have the river so high there will be no need to resort to flushing.

MR. ROBERTS: That will probably be the case, but in the removing of algae, which was one of the problems, you must realize that to raise the water gradually under a bed of algae moves it to a higher level, what we have to do is remove the algae and to do that you have to exert a flushing action on it. You can accomplish the same end by keeping more water in the river as a steady flow because you will create a velocity at which algae can't reproduce.

MR. HUGH TEMPLIN, FERGUS: Perhaps I might add a little more. Perhaps this runs a little too much to statistics, and not the human interest type which newspaper men look for, but the speaker might have said the first time we released 3,000 feet we nearly drowned three swimmers in the river. Whether that was wild life or not, I don't know.

12

"A RECONNAISSANCE SURVEY OF THE UPPER THAMES WATERSHED"

W. R. Smith
County Engineer, Middlesex County, London

On May 26, 1943, the London Branch of the Engineering Institute of Canada appointed a Committee,[1] for the purpose of gathering data to be supplied to the proposed Thames Valley Flood Control Commission. One object of this Committee was to carry out a reconnaissance survey of the upper Thames Watershed with special reference to the salient features of each tributary. In this way valuable time would be saved when the aerial and ground survey is made. This paper is the result of this survey and as Chairman of the Committee, it is my privilege to present our findings to this gathering.

In carrying out the survey, the Committee has been guided in a large measure by the findings of the engineers of the Muskingum Watershed Conservancy District of the State of Ohio which covers an area of 8,038 square miles. These engineers have stressed in their preliminary studies, and their subsequent construction work, the necessity of controlling the headwaters of small streams. To quote Mr. C. C. Chambers, engineer in charge of the Muskingum project during its inception and construction, and now its consulting engineer.

"A comprehensive general plan was prepared which provided for a system of main flood control and water conservation reservoirs, supplemented by channel improvement and local protection work at cities and other critical points. In addition, a number of small reservoirs were planned for some of the tributary streams to provide for water conservation and local flood control. This plan recognized that the work would not be complete until it was pushed back to the very headwaters of the streams and hillside slopes. It included reforestation work on the steeper slopes, and soil erosion control in cultivated fields, not only to preserve the forests and soil but to retard the run-off, conserve water and prevent the filling of the reservoirs with silt."

Also to quote Lt. Col. A. E. Arthur Jr., District Engineer:

"The wide distribution of reservoirs is essential, or else a storm of great intensity may produce a great flood without using more than a

[1] This committee was as follows: W. R. Smith, County Engineer, London (Chairman); W. G. Ure, Consulting Engineer, Woodstock; W. C. Miller, City Engineer, St. Thomas; W. R. Riehl, City Engineer, Stratford; H. C. Bates, Perth County Engineer, Stratford; W. R. Colby, Kent County Engineer, Chatham; T. M. S. Kingston, City Manager, Chatham; R. W. Garrett, Assistant City Engineer, London; H. F. Bennett, District Engineer, Department of Public Works, London and H. G., Stead, Engineer, E. Leonard & Sons, London.

Detroit News Photograph.

Part of the City of London, Ontario, during the flood of the Thames River, April, 1937.

small percentage of available storage. Reservoirs near the headwaters are in general cheaper per acre foot of storage and their benefits extend from the headwaters down, but must be supplemented by reservoirs of large capacity at key points on the main tributaries where large drainage areas may be controlled."

Furthermore, under the heading of "Water Conservation" Col. Arthur states: "the approved plan provided a certain amount of water conservation in a few of the reservoirs. Its purpose is to replenish the low water in dry seasons; to increase the ground water flow, and to provide recreational facilities and water supply for municipal and industrial purposes. Within the limitations of cost, water conservation is desirable and the most economical will be found in headwater reservoirs."

Now, using these findings as a basis for the work of our Committee we have spent no time on "the reservoirs of large capacity at key points" because these have already been most ably taken care of by an unpublished report prepared in 1938 by the Hydraulic Division of the Hydro-Electric Power Commission of Ontario.

The purpose of this present report, therefore, is to take care of those up-stream items of conservancy which Mr. Chambers and Col. Arthur state are so vital to the needs of a conservancy district.

A glance at the accompanying map (see page 109), will show that the largest number of natural storage basins still left to us are located in the highlands of the district adjacent to St. Marys, Stratford, and Tavistock. The Committee has therefore concentrated on those highlands in gathering information, though other valuable conservancy areas adjacent to London have also been covered.

The control of these small creeks is not only vital to water storage and soil erosion, but also for the spawning of fish, because the drying up of spawning creeks is one of the principal causes of steady decline of the Great Lakes fishery industry. No form of artificial propagation is equal to the functioning of the natural spawning streams.

While dipping for minnows in one of these creeks it was found that many of the small fry were pickerel and bass. These streams invariably dry up late in the summer and the loss of millions of fry is something that any red blooded Canadian should be willing to prevent, when these conditions are given publicity and the known remedy is at hand.

Another great loss to our commercial fishermen of the Great Lakes and to the sportsmen of our country is the destruction of the fish when spawning. Pickerel and pike ascend to the upper waters of the Thames where the country is herring-boned with drainage ditches. These ditches are generally kept clear of brush along the sides, which would afford some measure of protection to the spawning fish. Vast numbers are killed by the use of spears, shot guns and other weapons. Is there any wonder then that our once great fishing industry of the Great Lakes is on the wane?

I mention all this at this time to draw your attention to the fact that the prevention of run-off means more than the prevention of flooding houses in the urban centres. The prevention of run-off represents the right to live not only of our fish life (which is important) but also the right to live of thousands of our most virile and valuable Canadians, their children and generations yet unborn.

A. H. Richardson, the author of the Ganaraska Report, states that when he stands on a bridge during a freshet, he sees not only the boiling chocolate coloured water beneath, but envisions towns racing toward the seas, motor cars, furniture, barns, farm houses, office buildings, everything that makes up our civilization is in that chocolate water, because what affects the productivity of the land affects the economy of the whole watershed.

Will great dams alone stop this waste? You know and I know they will not. We have to go further up stream and handle the rainfall and the snow before it has a chance to become a torrent.

The winter of 1942-43 was a heavy one in the valley of the Thames. Snow was piled to great heights along our roadsides, and old timers

predicted a heavy flood when the thaw came. Due to unusual ice conditions in the ditches and culverts, the snow water was held up in the fields and reached the Thames slowly. The Thames at London rose only 3 feet and the water was almost blue in colour. This was a perfect spring freshet and may not happen again in a life time. Due to the clearness of the water large schools of pickerel and other fish ascended the Thames, and fishing was better that spring than it had been in the memory of many old fishermen. The taking of several lake trout was reported, which is most unusual in the Thames.

It is true that in the 1943 spring freshet we had many culverts wash out due to their accumulated ice, but the saving in erosion must have been worth much to the farmers. The lesson of this freshet to me was that if we can control the run off near its origin we will be performing a service to all of the people who live by the land, and also greatly lessen the cost of those control works that are necessary for the safety of towns.

It has been estimated by Hydraulic Engineers that about 60,000 acre feet of water should be retained on the four branches of the Thames. I am not suggesting that every culvert should be blocked or partially blocked, but I do say that a systematic survey would reveal thousands of locations where water could be temporarily held back with benefit to the land owner and to the Thames Valley as a whole. The total acre feet thus retained could then be deducted from the larger works recommended for the main streams.

It might prove that the construction and maintenance of these thousands of small controls would be more costly than the four large structures. What of it? The benefits would extend from the farmer in the highlands to the commercial fisherman in the Great Lakes, and the population that lies between.

The Committee of the Engineering Institute of Canada which I represent are not unreasonable in asking for a survey of the tributary streams. In the Muskingum Conservancy of Ohio, out of the 14 dams constructed 12 were on creeks and only two on rivers.

It is to be hoped that no time will be lost in installing gauging stations on all streams, followed by a complete survey of the watershed. It is felt that when this survey is commenced the information contained in this report on the tributary streams will at least define the areas most valuable for control purposes.

1. DINGMAN'S CREEK

Length 24 miles. 100 square miles drainage area. This creek is of great importance to the water supply of Dorchester, Westminster, and Delaware Townships, and it is probable that this drainage area

supplies a considerable part of the water pumped by the City of London from the Lambeth wells located on the North Talbot Road between Byron and Lambeth.

At the head waters of Dingman's Creek are a number of small lakes or ponds—Foster, Beattie and Mud Lake are of importance in the storage of water. Surrounding these ponds are submarginal lands suitable for water storage and reforestation. This stream dries up in certain portions but could be returned to a living stream at a moderate cost. It is well known as a spawning ground for pike and pickerel, but the fry are naturally lost when the stream goes dry. There has been a serious shortage of water in Westminster Township since the deepening of this creek under the Drainage Act about 10 years ago. The creek, once clear, is now muddy.

This creek has a fall of 75 feet in the 10 miles below No. 75 Highway, and having been straightened and improved under the Drainage Act is a badly eroding stream in addition to going dry a few weeks after the freshet. A system of automatic controls would be of value on this stream to improve ground water levels in Westminster Township and prevent further erosion of the stream which is becoming serious between Lambeth and Delaware. The control of this stream might be considered one of the utmost importance.

2. CROW CREEK

Length 6 miles. 12 square miles of drainage area. Empties into the Thames near Komoka in the Township of Lobo. This is a never failing stream fed by the Komoka swamp. This swamp contains and is surrounded by cleared submarginal land. Here are several thousand acres of land suitable for reforesting if taken out of private hands. One drawback is the threat of fire from the several railways that adjoin.

Beaver have been at work on the stream in recent years and a large herd of deer winter in the swamp. People existing in the area have usually run large store bills, and one Komoka storekeeper told me he could have bought the swamp with the unpaid bills of the transient owners.

3. OXBOW CREEK

Rises in the north west part of London Township and empties into the Thames at Kilworth 8 miles below the City of London. It is 18 miles long and has 72 square miles of drainage area. This creek overflows its banks and erodes badly through the Township of Lobo. In London Township the grades are flatter and there is little bank erosion. There is much sheet erosion in the valuable farm lands of London Township, and the stream is heavily charged with silt after every heavy rain.

A small power dam is located at Kilworth on this stream, which might be used for gauging purposes.

4. MEDWAY CREEK OR RIVER

With its head waters in Biddulph, emptying into the Thames at Broughdale, a suburb of London, is 18 miles long on the main stream and has several important branches. Has a drainage area of approximately 125 square miles. This main stream has been left largely unspoiled by the Drainage Acts but a large drainage scheme is liable to be started at any time.

Owing to its unspoiled condition the waters of the main stream are of a lighter color during freshets than those of the Thames. The stream has water storage in the form of a mill dam at Arva. At times there is a scarcity of water for the mill and any increased cutting of woodlots, or municipal drainage, will result in the demolition of the dam.

In Lot 20, Concessions 9 and 10, Township of Biddulph, is a low lying swampy area that could well be used for water conservation. This area has been a constant source of litigation.

Also, at Elginfield are located some low areas that could be pur-

The junction of the north and south branches of the Thames River, City of London, Ontario during the flood of April, 1937.

Detroit News Photograph.

chased and reforested to avoid expensive litigation and excessive deepening of the main stream.

At Lot 19, Concession 3, Township of London, is a valuable dam site on the Medway. This site is suitable for either water storage or flood control dam, without affecting the drainage of valuable agricultural land. A 50 foot dam would back the water up as far as Arva without affecting water rights. The Medway might be considered an important creek for immediate survey.

5. FANSHAWE CREEK

This is a small stream only 8 miles in length and about 12 square miles of drainage area, but it lies in a morainic area and check dams with some reforestation in this heavily cleared area would do much in the way of controlling run-off. There is already one check dam in operation in Lot 13, Concession 5, London Township; another one could be constructed in Lot 14, Concession 6, with valuable results. There is considerable acreage of unused land in this area most suitable for water conservation. This area contributes a considerable part of the water pumped by the City of London from the 4th Concession of London.

6. WYE CREEK

8 miles long. 24 square miles of drainage area. This creek lies entirely in West Nissouri Township and traverses one of the largest moraine areas in Middlesex.

Wyton was once the site of a dam and large mill on this stream, and the restoration of this dam would recharge much of the gravel area with water. Proposed dam on the north branch of the Thames near Fanshawe would also back water up the Wye Creek. There are no large natural storage basins on this creek, and other than the site at Wyton it is unsuited for dams.

7. WELBURN CREEK

This creek in the northern part of West Nissouri is 12 miles in length with several branches, and rises in a swamp located at Lot 30, Concession 12, East Nissouri, in the County of Oxford. It empties into the north branch of the Thames, Lot 28, Concession 3, West Nissouri. Steps could be taken to conserve this swamp and another further down stream in Concession 10.

Also, check dams near the outlet in Concession 3 West Nissouri would control bank erosion which is becoming serious. The source of this stream is on the westerly edge of the largest water production area in the Thames watershed.

What is meant by water production is year round flows, or natural protection of run-off.

About 500 acre feet of controls.

In the Welburn Creek district is Mud Lake. This lake is a favorite recreational centre with seats, booths, etc., and is a fair example of what can be done to make use of ponds and lakes. The area could be greatly improved by some clearing of trash and reforestation of sub marginal land.

Clean cutting of swamps has commenced in this area. A densely wooded swamp in Lots 18, 19, Concession 13, East Nissouri, is being cut clean. This should be controlled immediately. The results of clean cutting such an area can be seen on Cedar Creek south of Woodstock one mile west of Currie.

8. FISH CREEK

Rises in swamp land in the Township of Hibbert, Huron County, Concession 13 and 14, Lots 6 to 10. This swamp should be protected. At present it dries up in summer and is of little value to the maintaining of Fish Creek as a living stream.

The stream usually lives throughout the summer from Kirkton down stream to its outlet into the north branch of the Thames near Prospect Hill. As its name implies, it is a valuable stream for fish which spawn in the upper waters. It would be a disgrace if this stream should be permitted to dry up as occurs annually in the next watershed to the west where the Little Sauble has been drained to extinction. At the outlet of Fish Creek are valuable conservation features worthy of immediate survey. Here is another moraine area and a storage or flood control dam would be of great value.

9. TROUT CREEK

This creek probably supplies the largest percentage of low water flow of any tributary of the north branch, and the watershed contains many small swamps and natural storage areas, which could be developed at low cost. A flood control dam constructed a short distance east of St. Marys would appear practicable. The stream falls 23 feet in a distance of two miles but the floor of the valley is 1800 feet wide giving a capacity worth investigating. There are several other storage areas up stream. Trout Creek drainage area appears the most valuable of all the tributaries of the Thames for flood control and water conservation. A small dam at St. Marys holds back the waters of both Trout Creek and the north branch of the Thames. Used for milling purposes.

Aerial photography would be invaluable in mapping this very rugged area.

There is also a small dam at Harrington West.

10. FLAT CREEK

Empties into the north branch of the Thames a short distance above St. Marys. Has a suitable location for a flood control or dry

dam at its mouth; also a first class location for water conservation is located at Lot 11, Concession 2 in the Township of Blanshard near the hamlet of Anderson.

11. AVON RIVER

The Avon River is about 25 miles long, emptying into the Thames 3 miles above St. Marys. The watershed is about 56 square miles. Near Shakespeare are to be found the headwaters of the Avon River and the Nith. Horner's Creek also rises here emptying into the Grand above Brantford, also a branch of the south branch of the Thames. Truly these are the highlands of Southern Ontario, and conservation of underground supplies of water here is of great importance to the entire country.

Much of the watershed in Ellice has natural drainage from a strata of gravel 3 to 6 feet below the surface.

In Concessions 7 and 8 North Easthope there is an area of 1300 acres of flat land not under cultivation, given over to swamp willow and poplar with some natural bush in between. In Concession 5 and 6 are 650 acres similarly not devoted to agriculture. East of Stratford the country is rolling with splendid fertile farms, but containing swamps that are of value for water storage purposes. One swamp in the area around Lots 25 and 26, Concessions 3 and 4, North Easthope, is 400 acres in extent. In South Easthope, near Stratford, is an area bordering on the submarginal, comprising 400 to 500 acres.

In the whole Avon watershed no more than 300 acres have been reforested. Some 3000 to 6000 acres could be reforested with slight if any decrease in agricultural production.

The Avon River drops 50 feet into Stratford and has 125 feet of fall below the City. A number of fine springs are located in the headwaters in North Easthope. The underwater table is gradually falling around the eastern limits of the City. Stratford being at the headwaters suffers little from floods but would benefit from a substantial increase in low flows.

The way in which Stratford has beautified the river banks, and controlled erosion within the City limits, is an example for all of Ontario. There is also a good example of steep bank protection by conifer planting at the mouth of the Avon.

Stratford has now 18,000 population, is progressive, and will no doubt require an increase instead of a decrease in its ground water and river supplies. The sewage disposal plant at Stratford, so far as the effluent is concerned, is a model of efficiency and no pollution could be observed at the St. Marys dam from the discharge of sewage at Stratford.

The Valley of the Avon is undoubtedly of the utmost importance in boosting the low flow of the Thames. The adjacent watershed of

Trout Creek, Black Creek and the headwaters of the south branch of the Thames, are of almost equal importance.

The Valley of the Avon with its rolling, fertile lands interspersed with suitable reforestation areas is pre-eminently suited for conservation work, and not only would Stratford benefit but the entire Thames watershed.

Stratford's ground water table has dropped 2 feet in a period of 15 years.

The Canadian National Railways use 155 million gallons of river water yearly (425,000 daily). Stratford uses 2½ million gallons (Artesian) daily. The need of controlled run-off for the Upper Avon is clearly indicated here.

12. BLACK CREEK

Rises in the Ellice Huckleberry Swamp, flows 29 miles southwesterly emptying into the Thames at a point 8 miles above St. Marys. Fall 150 feet. The watershed is about 44 square miles.

In Fullerton and Downie Townships the land is gently rolling and fertile with no large areas of waste land. The northerly portion consists of the Ellice Swamp about 2500 acres in area. This swamp extends northerly into the Nith watershed.

The swamp extends easterly across No. 19 Highway into North Easthope where another 700 acres is covered with stunted willow and poplar. Probably 600 to 800 acres could be used for reforestation without detriment to agricultural interests. Good trees can be grown in the Ellice swamp but the menace from fire is great, due to dried out peat.

1¼ miles south of Sebringville is a good site for a storage dam. Stream flow is practically nil in dry seasons.

Progressive stripping of wooded areas and the continual improvement and extension of drainage is undoubtedly the cause of small stream flows during the summer months. Springs do not seem to have the usual prevalence especially in the upper half. Improvement and deepening of wells in the watershed has been a necessity. Very little reforestation has been done in this watershed.

13. CENTRE BRANCH OF THAMES

Rises in north West Zorra and is important for flood control and water conservation. Erosion serious in upper reaches. Mud Creek is an important tributary. Both these streams have valuable sites for flood and storage dams. Old glacial channel east of Thamesford should be surveyed for water storage; much waste land lies in bottom of old channel and it has good width and depth. Proposed flood control dam site is 2 miles up stream from Thamesford but location should be moved ½ mile or so upstream as there appears to be a mistake in topographical map at this point.

Valley from old channel to junction with Mud Creek excellent for flood control or water storage. Mud Creek has excellent storage capacity.

Rough land at head of Centre Branch is too steep for cropping and many fields should be grassed before it is too late. Vast moraines are in this area and the swamps that lie between are invaluable storage areas for water of the highest quality.

14. NORTH BRANCH OF THE THAMES

The North Branch is often described as a flashy stream, and this is easily understood when it is realized that there is a fall of over 400 feet from the heavily drained plateaus of Perth and Oxford Counties to the forks at London. Commencing at these forks and proceeding up stream the westerly bank is protected by a concrete faced dyke. In 1937 the crest of the flood rose 24 inches over the top of the dyke, flooding London West. At Broughdale in London Township many cellars were flooded in the 1937 flood and one house was seriously damaged. London Township has since done some channel improvement to remedy this situation.

4 miles upstream from the forks a serious situation is developing at Adelaide Street. The river here is rapidly changing its course due to erosion of successive floods. A break through can be expected at any time which will necessitate the expenditure of upwards of $100,000 by the London Suburban Roads Commission, the Ontario Government, and London Township.

As far as Thorndale at least the river passes through a flat moraine and the proposed dam at the Townline of London Township and West Nissouri would be valuable for water conservation in this moraine, providing a conservancy pond was included in the design of the dam.

Standing on the bridge at the townline between Middlesex and Perth one is impressed by the scarcity of water in the 200 foot channel bottom. Much of it is dry and a system of submerged weirs from this point to the Thorndale bridge would be of value without affecting agricultural lands.

A small storage dam at St. Marys holds back the water of the Thames and that of Trout Creek.

Flat Creek enters about 2 miles above the Town of St. Marys and this is the site of the proposed dry or flood control dam. The site is well chosen. Some objection was raised that this dam might cause a nuisance being below the sewage disposal plant at Stratford. This objection would not apply to a dry or flood control dam.

There is a storage dam site at Motherwell. Up and down plowing is observed along the steep banks of the Thames around Motherwell and erosion is very prevalent until the flat lands are reached above Mitchell where there is a low storage dam.

Some pollution was observed below Mitchell, which could probably be alleviated by an increase in minimum flows. The country upstream from Mitchell is flat and intensively drained. On the Townline between McKillop and Logan Townships, Concessions 11, 12, 13, 14, 15 and 16 of Logan, there is a large area of land with no houses, and suitable for reforestation although the fire hazard from drained black muck is great. Fires were observed burning in this black muck in Concession 15, in spite of heavy rains.

The north end of this area drains into the Middle Maitland River via the Beauchamp Creek Drain.

In the North Thames watershed alone are several thousand acres of submarginal land which would provide work for many families, if reforested. This flat land is heavily cleared and reforestation would be of value to the entire North Thames watershed.

A large moraine was observed in Lots 30 and 31, Concessions 14, 15 and 16 of Logan Township, and reforestation here would be valuable for ground water levels.

The watershed of the North Branch of the Thames might be described as one of the most heavily drained regions in Ontario, and on account of the steep gradients all of the water is quickly run off entire Townships. The Township of Blanshard is typical of this.

The result of this drainage is well illustrated by a table prepared from Dr. Norman Marr's data on minimum flows in the Grand and Thames Rivers:—

Stream	Square Miles Watershed	Minimum flow C.F.S.	Square Miles per C.F.S. flow	
Whiteman's Creek	154	82	1.8	Paris & Waterloo moraines
Speed River	250	125	2.0	Moraines
Nith River	128	430	3.3	Paris & Waterloo moraines
Grand at Brantford	2000	380	5.0	Average country
Irvine River	67	11	6.0	At Elora
Fairchilds Creek	115	15	8.0	Near Onondaga
Boston Creek	125	16	8.0	Near York
Grand at Belwood	280	35	8.0	No moraines
Thames—South Branch	515	66	8.0	Heavily cleared
Thames—North Branch	585	29	20.	Heavily cleared; moraines

It will be noted that the heavily wooded moraine country of the Whiteman Creek watershed supplies about one quarter of the flow of the Grand River at Brantford though it drains only one seventh of the Grand River Area.

During the year 1918 the South Branch of the Thames dropped to 2 cubic feet per second. Average 131 cubic feet per second. During 1919 the North Branch also dropped to 2 cubic feet per second. Average 22 years 96 cubic feet per second. During 1918 and 1919 the main stream at Byron dropped to 12 cubic feet per second. The average flow for the main stream for 17 years was 550 cubic feet per second.

It will be seen by the above figures that both the North and South Branches of the Thames are dangerously near to completely

drying up during the summer months, endangering the water tables of the entire watershed, and the health of our communities.

It is possible that a survey might reveal the practical use of dykes to flood the unused lands at the head waters of the North Branch, Black Creek and Avon. These dykes would run completely around the unused lands and hold back the water from flooding adjacent pasture or crop lands. Small controls could be built across the canals that have been dug in attempting to drain these areas. Fire hazard would be eliminated and a large water reserve created at a possibly low acre foot cost.

15. SOUTH BRANCH OF THAMES

Rises in a long swamp located on the north Townline of East and West Zorra, Concessions 7, 8 and 9, a short distance west of Tavistock. This swamp is largely under forest and should be acquired for conservation purposes. The close cutting or drainage of this swamp would be disastrous for the Thames Valley as in its present state it is exerting a large measure of water conservation and flood control. The same applies to Trout Creek which rises in the same swamp.

Erosion is most prevalent along the high hills surrounding Trout Creek and the upper reaches of the South Branch of the Thames. It is evident that any attempt to drain swamps at the foot of these hills is doomed to failure as the top soil from the surrounding fields will rapidly fill the ditches up again.

Interesting features of the South Branch are the large quarries located at Beachville, near Ingersoll. The South Branch broke into these quarries during the 1937 flood and the effect was to lower the crest at London by 3 feet for several hours. Thus the crest of the North and South Branches did not coincide, which helped the situation considerably.

The water retained by the various quarries was as follows:—

Canadian Lime & Alebestine Co.	2134 acre feet
American Cyanamid Co.	1840 acre feet
Chemical Lime Co.	213 acre feet
Total	4187 acre feet

16. WAUBUNO CREEK

Fourteen miles long, area 60 miles. Rises in East Nissouri in the County of Oxford, and another branch in West Nissouri in the County of Middlesex. This creek generally traverses a flat plain and is not adapted to the construction of dams, except near the mouth south of Crumlin where there were several dams in the past.

On the Townline of East and West Nissouri in this drainage area are the Cobble Hills that rise 100 feet above the plain. These hills are largely gravel and contain some natural storage basins. They are of little use for agriculture, the pasture being poor. They would,

Broughdale, highway number four, during the Thames River flood, 1937.

if reforested, be a valuable contribution to flood control and water conservation.

17. DORCHESTER SWAMP CREEK

Five miles long, area, eight square miles. This creek is so small as to scarcely show on the map, but drains an area that might well be acquired for water conservation. The swamp is largely covered with small timber and is surrounded by submarginal land which could be acquired for reforestation.

A small dam is at the outlet and the mill pond is a favorite recreation centre. There are also several small lakes within the area. As many as 30 deer in one band have been reported in this swamp.

This watershed meets the watershed of Dingman's Creek and the two low lying areas could be handled as one forest reserve.

Very important area.

18. REYNOLD CREEK

Eighteen miles long, area, 70 miles. Rises at Zenda on the Townline between Dereham and Norwich in the County of Oxford, and has a very flat gradient, but the surrounding country is rolling causing sheet erosion and the stream carries much silt during floods.

There are many small swamps, and reforestation would be of value. No dams are possible due to damage to agricultural land.

Reports have come in that extensive flooding has taken place east of Avon since the clear cutting of a large woodlot about 5 years ago by the Hay Company of Woodstock.

A number of small swamps could be saved.

19. CEDAR CREEK

Cedar Creek is one of the smaller tributaries having its outlet into the South Branch of the Thames at the west end of the City of Woodstock. It has a length of about 9 miles and drains an area of about 35 square miles. Its course is practically straight south from the City.

The upper three miles is not much more than a ditch and goes dry in the summer time, and lies through fertile agricultural country. In the area from 5 to 6 miles above the outlet there is a lot of cedar swamp land with numerous flowing springs. Most of the water from these springs is piped to the City through 18″ pipes and forms the water supply of the City of Woodstock. There is, however, sufficient spring water left flowing through the creek to make it a living stream. Considerable reforestation work has been done for the protection of the City's water supply and it has been found that the flow of water in the springs has remained remarkably constant since 1890 when gaugings were first made. The land along the creek for a distance of about 4 miles, commencing at the southerly boundary of the City and extending south to include these spring areas, is well fitted for conservation purposes.

There are two dams now on the stream; one in the City to form a pond for pleasure purposes, and one about 3 miles south which provides power to run a chopping mill.

West of the Cedar Creek area in South Oxford and North Dorchester Townships, between Peebles and Putnam, there is an area draining into the Thames which is a valuable source of underground water. Some reforesting is being done on the badly eroded hills and could be greatly extended with benefit to the good agricultural land nearby. There are also several excellent swamp areas for water storage. One mile west of Currie is a devastated swamp cut clean and an eyesore. It should be taken out of private ownership and if replanted with cedar would be returned to its proper use in a very short time.

UNDERGROUND WATER LEVELS NEAR LONDON

A separate report might be written on the water situation for the City of London. London does not make use of river water for drinking purposes but uses springs and deep wells. The watershed around London is almost completely cleared and the run-off at times will be 100 per cent.

Several years ago Mr. E. V. Buchanan asked me for an explanation of why the springs at Springbank had been reduced in daily flow some 500,000 gallons since 1919. This was a very easy question to answer after living for 20 years in that district. 300 acres had been slashed from the hills surrounding the springs, and also the chestnut with which the hills had been covered had all died from blight, and had not been replaced by other species.

Recently Mr. Buchanan was good enough to supply the figures for the Springbank pumping station since 1919, as follows:

		Million Gallons
1919	Venturi Meter Installed	1226
1920		1214
1921		1302
1922		1313
1923		1297
1924	Pitometer test made	1300
1925		1032
1926		1031
1927		1052
1928		1059
1929		972
1930		987
1931		869
1932		891
1933		928
1934		888
1935		809
1936		967
1937		1083
1938		1083
1939		724
1940		938
1941		972
1942		873
1943		976

The actual reduction in flow is 689,000 gallons daily according to the above figures.

This is typical of the effect of the lowering of our water tables throughout Ontario, and so far as I can find out, Beeton, Ontario, with a population of 600 is the only municipality which has completely protected its watershed by reforestation. It took 10 years after planting to restore the flow of springs to their original quantity.

By way of contrast, the Republic to the south has adopted protection of watersheds as common practice. New York City, Boston, New Haven, Troy, Carthage, Glen Falls, Reading, Pittsburg, and Little Falls are a few of the northern cities that have adopted watershed protection up to 25,000 acres or more.

London uses 7.6 millions of gallons of water daily but its watersheds lie unprotected at the mercy of private owners. I do not know what powers urban centres have for expropriation of lands for watershed protection but if they have not the power it should be taken care of by a Town Forests Act such as is in force in Massachusetts.

Watershed protection for the City of London is a paper in itself. There is no time for further information.

On account of deforestation, roads in the London Suburban Area are very difficult to maintain. Washouts of culverts are frequent and many culverts have had to be enlarged and still are rapidly filling up with top soil. The area from Byron to Lambeth is worthy of a special report.

A former stream feeding a mill at Byron now runs only for two days in the year and in those two days destroys acres of top soil besides causing much sheet erosion. One fruit grower by the name of Cornell has done some planting to protect his hillsides from wind and water erosion but the City of London has done very little but ornamental planting on the 300 acres of Springbank Park.

SUMMARY OF REPORT

1. At least 10,000 acres of submarginal land are available in the upper Thames watershed for reforestation and improvement of ground water supply. Agricultural production in the fertile lands of the valley would thereby be increased.

The only areas where arable land should be used would be in the area around London for water supply, and in Biddulph Township to insure the continuance of the Medway River as a living stream.

2. A Conservancy Act for Ontario is vital to the carrying out of any of the conservation work suggested in this Report.

3. The Drainage Acts could then be amended to conform to the laws of conservancy.

4. Immediate legislation should be passed to control encroachment on river bottom lands by buildings, subdivisions, or dumping that might cause loss of life or property damage.

5. The following table summarizes flood control costs from various authorities:-

Muskingum River—$43,065,687 for 1,539,200 acre ft. = $28. per acre foot.

Muskingum River Tappan Dam—$3,425,004 for 61,600 acre ft. = $55 per acre foot.

Ganaraska River (estimate)—$653,000 for 17,500 acre ft. = $37 per acre foot.

Grand River, Fergus—$2,056,487 for 46,000 acre ft. = $45 per acre foot.

Thames River at Springbank—$140,000 for 1,000 acre ft. = $140 per acre foot.

While much of the data in this report has been gathered by various members of the Engineering Committee, the preparation of the paper and the analysis of the data is that of the writer.

DISCUSSION

CHAIRMAN DETWILER: Ladies and Gentlemen: We have often heard it said that Providence helps those who help themselves. From the information just given, I think it is evident that we are helping ourselves. I wonder if we might suggest to the Department of Planning and Development that it pass this bit of information on "higher up" on our behalf.

This paper shows, I believe, a very good beginning in the study of what, as you have seen by the outline of the paper, is a concrete problem here. It furthermore shows, as intimated before, that we are trying to help ourselves.

DR. BLISS: I was particularly pleased to hear Mr. Smith stress the value of the fish life in the Thames River, specially after hearing so much discussion about our other natural resources.

I may say that there is a strong representation here concerned with game and fish in Southern Ontario, and I would like just in passing to impress upon the Department the necessity of appointing adequate representation from this field on any Committees which may be appointed.

DR. OTTO HOLDEN, TORONTO: I was very pleased and interested in one or two remarks in Mr. Smith's paper. I found the whole of it of very considerable interest, but I would like to repeat something that he mentioned, and that was the urgent need for the collection of data in regard to the Thames drainage basin, and also any other drainage basins on which works for flood control or conservation of water or soil may be contemplated. The value of such records depend in large measure on the length of the period over which they extend. Outside of the main rivers in Ontario I believe that the Thames and the Grand are the only two on which records of flow have been secured for any lengthy period, and on the Grand this is at only one point. That was at Galt. On the Thames, stations have been maintained at Fanshaw on the north branch, and at Ealing on the south branch.

I might say that all of these three have been maintained by agencies whose prime concern was not flood control or water conservation for general purposes within the area, and I would like to impress on the meeting here the need for the securing of this data. I well realize that all small streams and creeks cannot have gauging stations and stream flow recordings established on them, but the rivers such as the Thames, the Grand, the Ganaraska, and some of those should certainly be covered and typical streams coming off certain varieties of drainage areas in which are included various types of soil and cover would be of great help to whoever undertakes in the future the design and operation of works for the purposes mentioned above.

CHAIRMAN DETWILER: The last speaker told us what Mr. Richardson saw when he looked into the swirling waters of floods. I saw the last one on the Thames. That was in 1937. I didn't see the previous one. When I look into floods now on the Thames I don't imagine I see bridges and houses and fences going down stream. I see back on the hills, forests; I see strip-cropping on the slopes, I see the water coming down under control, and I hope this meeting will be prophetic of the thing I see.

Last summer I studied some of these problems in the adjoining State of Michigan; a State most like Ontario in geologic history, soil, etc. I crossed most of the Lower Peninsula with drivers who were soil conservation specialists, and as we drove along, or stopped to examine, they were my instructors. Sometimes they would say, "Now there is a hill you would not contour". Some of us have thought, seemingly, that contour farming and strip croping would be the answers to most of our hillside difficulties, except on steep slopes. Where the hills were "hummocky" as they expressed it, such hills they said should be returned to grass or forests; particularly, now that we have adjusted farming to the operation of tractors. Along the long moraines, such that were gently sloping they would say "There, contour farming and strip cropping are feasible to overcome soil erosion and water loss". In Southern Ontario we have many of these moraines, and would that our surveyors had had the vision and had laid out our farms and roads parallel to the south-west and north-east moraines, our roads would now tend to pass along the crest of these hills or in the valleys between, and we would strip-crop and contour-farm more or less naturally.

I would say this, that contour farming and strip cropping are not panaceas. This type of cultivation presents a complicated problem and we need good conservation engineers to carry out our programme.

MR. BRUCE BRADLEY: I would like to ask Mr. Smith, if he knows what the difference in elevation of the Thames River in summer time is between London and Chatham. That is at the time, we will say, August 1st, when there is very little flow,

at least at Chatham. I want to get a picture in my mind of the water levels between London and Chatham.

MR. SMITH: I haven't that information sufficiently definite to answer the question. The steep fall on the river ceases about Delaware. If I remember rightly there is about six feet of fall per mile on the north branch, about eight feet on the center branch, and about six feet per mile on the south branch. The fall from Delaware to Chatham is very, very light, only probably one or two feet per mile. Then from Chatham to the lake it is practically level. I can't give the absolute figures.

MR. HUGH TEMPLIN, FERGUS: It seems there has been one thing stressed over and over again that we shouldn't miss. Mr. Smith mentioned a bit of swamp here and bush there that it would be disastrous to drain or remove, and everyone else has mentioned the same thing, one way or another. Dealing with stream flow and water in the Grand River Valley, we know there are swamps that shouldn't be drained and it seems to me some power should be given to conservancy bodies to prevent that. The Act under which the Grand River Conservation Commission exists gives that power. I don't know that it is always enforced but we have it. I think that is one of the vital steps.

We have had too much drainage that has been encouraged and one man may start a drainage scheme that may bring disaster to his neighbour and everyone down the line.

I have in mind one case on the upper waters of the Grand, on the boundary between Dufferin and Wellington Counties. I used to drop in often to see a man who had 200 acres on an island in the heart of the marsh. He had only two neighbours. He lived alone and he read very little. He had a grudge against one neighbour to the east. We found out later that if the fence between him and his neighbour had been where he thought it ought to be it would have made a difference of $13.00 to him. He had spent a great deal more than that trying to prove it was right. He said one day "I am going to start a drainage scheme. It is going to cost me $1000. I have saved that up. It is going to cost him a lot more than that and he hasn't got it."

That was the beginning of that one drain from the Luther Marsh down through the Grand River. (Other drainage schemes began in Luther as early as 1890.)

There is an interesting human side. A few years later the man who had started the drain through brooding on his trouble died in the asylum. I never met the man that he didn't like but I did know the man up stream, and his wife came in to see me two or three times. He was a young man with three children. She had been a school teacher. She came in to see if the Commission wouldn't buy their farm. She said if we would buy they could get out of there—she thought her husband was going out of his head. Later she came in and said he had been taken to a mental institution. After he had been there a month or two they thought he was cured and he was sent home and that night shot himself.

The ditch ran down about two miles or so. I went in the fall after it was built and I said to the man at the end of the ditch, "You are going to have a lawsuit on your hands. I think next spring you are going to flood out your neighbour across the road." He said, "O, well, nobody likes him anyway. We don't care what happens to him."

He was flooded out and started his suit against the Township of East Luther, and I believe the total cost is $28,000, roughly. It hasn't done anybody any good, except that when the dam is built it is going to be on this ditch, but as we plan to dam up the water on all those farms all that work will have been done for nothing.

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REPORT OF THE RESOLUTIONS COMMITTEE

Professor R. F. Legget

Department of Civil Engineering, University of Toronto, Toronto

THERE are few meetings which I have attended at which I have heard so much discussion about resolutions, and I take that as one of the greatest tributes that could be paid to the success of this Conference. Some idea of what that discussion has meant may perhaps be obtained from the fact that the Resolutions Committee have been sitting continuously since about half past one. We have just come down now with the results of our deliberations. At the outset, Mr. Chairman, I wish to pay tribute to the patience and forebearance of my colleagues on that Committee who have given up the afternoon for the purpose of preparing what I now wish to present to you.

Before presenting the resolutions, Mr. Chairman, and at the instruction of the Committee, I am to say that in our considerations we have gone over carefully every single suggestion which was made to members of the Committee. We have therefore considered carefully the two propositions just made by Mr. Crittenden, but we have come to the conclusion, sir, that while there are a great many matters about which we could make resolutions if time permitted, they are in themselves relatively detailed matters. We think therefore that it would be better if we left them for the consideration of a more appropriate body.

In order to let you see what we have been considering, I am instructed to read to you a list of the subjects which have been considered, but which are not specifically mentioned in our resolutions. We are sure that they can be and will be forwarded to the appropriate authority at the conclusion of this meeting.

First, there is the general question of stream pollution, which comes under the aegis of the Department of Health;

Secondly, there is the essential part which biologists should occupy in all conservation matters, and the places which they should occupy on Conservancy Boards;

Third, the question of Daylight Time;

Fourth, the details of the existing Drainage Acts which we are going to mention in a general way;

Fifth, the suggestion of a breakwater on the shore of Lake Ontario;

Sixth, the possibility of copying the Ohio Conservancy Act in Ontario;

Seventh, the question of necessary surveys and maps in relation to Conservation;

Eighth, the desirability of fostering community action in relation to conservation;

Lastly, the question of surveys for land use.

These are matters, Mr. Chairman, which have been considered, but which we feel are generally covered by the general resolutions which I now wish to introduce. Our request, Mr. Chairman, is that if the resolutions which we wish to present are accepted by the meeting, you would be good enough to pass them, sir, to the Honourable Dana Porter, with the request that he present them from this Conference to the Premier of this Province.

The first resolution is the most important and the most general and before I read it, I want to say one word of explanation.

You heard last evening a resolution read, sent up as a trial balloon, so to speak, which has created much useful discussion. We have taken the results of that discussion and prepared a new resolution which we think meets all the objections we have heard to the one read last night. In seeking the setting up of a central authority, we are using the term "conservation authority," but the word "authority," has a small "a". I do want to make that clear because we do not feel we should suggest the type of authority. It may be modification of existing departments, it may be a Commission, it may be some new body. All we do wish to suggest is that some central agency should be set up.

Therefore, Mr. Chairman, as I read the resolution, would you please remember when I use the term "conservation authority," I am using it in the general sense, and not to designate any specific type of single agency.

(The following resolutions were then presented, moved by the chairman of the resolution committee, seconded by an attending delegate and passed by the conference.)

Resolution No. 1:

Whereas there is urgent need for an active programme of conservation of the renewable natural resources of Ontario—water, soil, crops, forests, fish and wildlife; and

Whereas all renewable natural resources must always be considered as parts of an integrated whole, and not individually, in all phases of conservation;

Therefore be it Resolved that the Government of Ontario be urged to establish a Conservation authority for Ontario, responsible to the Government, having as its principal function the bringing about of co-ordination and co-operation amongst all agencies in Ontario carrying on and promoting conservation projects with the object of formulating

and putting into effect a unified programme for the rehabilitation and wise use of all our renewable natural resources.

Amongst the specific steps which should be taken by such an authority are:

(a) Assisting in the promotion of local conservancy projects throughout the Province;

(b) Acquiring, by purchase or otherwise, submarginal areas to be held in trust for conservancy purposes;

(c) Ensuring that all works intended for flood control purposes are properly correlated with the general principles of conservation practice;

(d) Considering the operations of the existing drainage acts in relation to conservancy work with a view to the prevention of the use of these acts for the drainage of lands which should preferably be left undrained;

(e) Maintaining contact with neighbouring provinces and states for the assembly and exchange of information and the correlation of appropriate programmes of work in relation to natural resources common to Ontario and neighbouring areas;

(f) Assisting in the training of technical personnel for the carrying out of conservational work; and

(g) Fostering the direction of adequate attention to all phases of the conservation of natural resources in all the educational work of the Province of Ontario.

Resolution No. 2:

Whereas the well-being of all renewable natural resources is fundamentally dependent upon adequate ground-water supplies; and

Whereas it is believed that the groundwater levels in southern Ontario are generally receding;

Therefore be it Resolved that the Government of Ontario be urged to arrange for an early start and an inventory of groundwater supplies in Ontario, in conjunction with the Geological Survey of Canada.

Resolution No. 3:

Whereas this Conference on River Valley Development held in London has been most instructive and informative to those who have been able to attend; and

Whereas numerous requests have come from municipalities and interested organizations in Eastern Ontario that a similar conference be held in that area;

Therefore be it Resolved that this Conference support the petitions of the municipalities and others from Eastern Ontario and that the Minister of Planning and Development be requested to consider holding a similar Conference in Eastern Ontario at an early date.

Resolution No. 4:

Whereas this Conference on River Valley Development has marked a vitally important step forward in the public appreciation of the necessity for the rehabilitation and conservation of natural resources in Southern Ontario; and

Whereas this Conference was initiated, organized and financed by the Department of Planning and Development of Ontario, with the assistance of a regional committee on local arrangements;

Therefore be it Resolved that the thanks of the delegates assembled in final session be extended to the Honourable Dana Porter, Dr. George Langford, Mr. A. H. Richardson, Dr. G. D. Detwiler, Mr. W. H. Porter and all others associated with them for their successful conduct of the Conference, and for the great privilege of participating in its stimulating proceedings.

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CLOSING REMARKS BY THE HONOURABLE DANA PORTER

WHEN this meeting was first conceived I don't think that any of us pictured the great success with which it has met during the last two days. It is very gratifying indeed to us of the Department of Planning and Development, and I am sure to the Government as a whole, to find the very wide spread interest that has been shown in the problems that have been before us.

I may say it is also very gratifying to find that in other parts of the province, as a result of the success of this meeting, a similar meeting is desired, and I hope that in due time we may give full consideration to the resolution directed to that end.

I would like to say that the success of this meeting is really due to the activities of certain voluntary associations which have been going on for the last—well, I don't know how many years. Sometimes it is necessary, in order to bring an idea to fruition to be prepared to spend perhaps ten years of developmnet before full recognition may be obtained. Nevertheless, we seem to have arrived at the point where we can expect full and even enthusiastic public support to a really forward looking policy of conservation, and I may say that we have reached this point as the result of a great deal of work that has been done over the past number of years by groups of men who have interested themselves and devoted themselves to work of this kind.

It has been a very great pleasure to have been associated with this meeting and I wish to thank the members of the Advisory Committee and of the Conservation Associations, and I also particularly wish to thank Dr. Detwiler for all he has done to make this conference a success.

MR. BRUCE BRADLEY: Mr. Chairman and Mr. Minister. I have not got it clear in my mind whether any definite arrangements have been made for the necessary survey of this flood water control system. I represent a group of ratepayers who have authorized me to come here and tender $100 toward the survey and I do not wish to go home without getting the necessary information whether steps are definitely going to be taken or not.

HONOURABLE DANA PORTER: I wouldn't like you to go home and take that $100 with you. I don't know that I am quite in a position to say as to whether that particular survey or some other particular survey is to be carried out. The most I can do is to assure you in a general way that the resolutions as presented at this meeting will be presented to the Government and I am sure that every step will be taken to carry out and bring to a head the conservation policy which will probably meet with your satisfaction.

MR. BRUCE BRADLEY: We just want to render our little support because the control of the Thames, which is no one's particular fault, has represented a great many thousands of dollars of damage over the years and has caused it to be necessary to spend many thousands of dollars in flood control programmes and I, as one individual, wish to express my thanks to you, sir, and to the Committee, for arranging this excellent programme, and I only wish that the news on soil and water conservation could be brought home to the people of the municipalities of Ontario by missionary work on the part of speakers who could present, possibly through Service Clubs, with farmers invited, this very excellent information.

While all the papers have been fine, the addresses of Professor Albrecht and Professor Rhunke are so important to farmers and to towns that depend upon the surrounding country, that if those addresses could be given repeatedly with these lantern slides that are so graphic, I think that public opinion could be formed and aroused to a knowledge of the need of these things from which would come undoubtedly vision and action.

HONOURABLE DANA PORTER: Thank you very much for the useful suggestion. I don't think it has happened in the last six months I have been in office that anyone has suggested that $100 be presented to the Government. I would say it is one of the most encouraging things that has happened.

Now, if there is no further business, Ladies and Gentlemen, I declare the meeting adjourned.

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